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Strategic Defenses and the Transition to Assured Survival

Glenn A. Kent and Randall J. DeValk

October 1986

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RAND

PREFACE

President Reagan proposed on March 23, 1983, that the United States undertake a program to explore the possibilities of developing and eventually deploying effective strategic defenses. His proposal prompted Rand to examine the implications of a transition from the current U.S. posture, based solely on offensive weapons and no strategic defenses, to one relying predominantly on nationwide strategic defenses.

The study, conducted under the National Security Strategies project "Contemporary Arms Control Issues," funded by Project AIR FORCE, focused on the ballistic missile aspect of the transition. The present report, which documents the findings of the study, should be of interest to decisionmakers who are involved in the current debate on the President's strategic defense initiative and who believe that a critical examination of the transition to a robust strategic defense system is needed.

SUMMARY

This report details the anatomy and calculus of the ballistic missile portion of the transition to a robust nationwide strategic defense posture, as proposed by President Reagan on March 23, 1983.[1] To provide insight into the policy issues surrounding the transition, we develop an analytic format based on ballistic missile "defense potential." We then use the defense-potential format to demonstrate how various postures of strategic offensive, defensive, and defense-suppression forces might interact to provide or deny each superpower certain strategic capabilities.

Strategic capabilities include the capabilities for "assured survival" and "conditional survival" from ballistic missile attack.

- **Assured survival implies the capability to survive as a nation under all circumstances, including an enemy first strike.** To attain this posture, a nation would have to deploy highly survivable defenses that could intercept nearly all of the weapons in the enemy's arsenal of strategic ballistic missiles.
- **Conditional survival implies the capability to survive the ragged ballistic missile retaliatory attack of the enemy** after one's own first strike against the enemy's offensive, defensive, and defense-suppression forces. Unlike assured survival, conditional survival would not require invulnerable defenses.

The report concludes that only the following two postures would offer both first-strike stability[2] and arms-race stability:

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[1]The term *nationwide strategic defenses* refers to ballistic missile defenses that would consist primarily, but not solely, of space-based components; we assumed that when on station these defenses would be capable of intercepting any reentry vehicle (RV) in a given enemy attack involving ballistic missiles. We make no judgment as to whether the United States or the Soviet Union is technically capable of deploying ballistic missile defenses robust enough to provide the capabilities discussed in the report. The analysis simply examines how various changes in the U.S. and Soviet postures of offensive and defensive forces would affect a transition to robust nationwide defenses.

[2]First-strike stability exists when neither side has the incentive to launch a disarming first strike on the other's strategic forces: That is, neither side calculates that it would be considerably better off, in relative or absolute terms, after launching a would-be disarming first strike against the other and neither side feels pressed to launch a first strike in order to avoid the far worse consequences of going second.

- **Mutual assured retaliation,** in which both countries possessed—and could continue to possess, regardless of an adversary's actions—the capability to retaliate and, in so doing, to inflict massive, unacceptable damage on the attacker
- **Mutual assured survival,** in which both countries possessed—and could continue to possess, regardless of an enemy's actions—the capability to survive as a nation under all circumstances.

The unilateral U.S. or Soviet possession of the capability for assured retaliation, conditional survival, or assured survival would trigger an effort by the other to attain this same capability for itself; hence, it would cause arms-race instability. Mutual conditional survival, a posture in which each superpower had the capability to execute a disarming first strike, would lead to extreme first-strike instability.

The defense-potential format demonstrates that if highly survivable strategic defenses were deployed as an adjunct to current superpower ballistic missile forces, the United States could make the transition to the President's goal of assured survival from ballistic missile attack without having to pass through a destabilizing period during which either country possessed the capability for conditional survival from ballistic missile attack.

The avenue along which a stable transition would be possible is fairly wide.[3] **If, however, both the United States and the Soviet Union continued to deploy reentry vehicles (RVs) capable of destroying hard targets but failed to adopt corresponding offensive force survivability measures, the avenue to stable transition would close.** The absence of offensive force survivability measures would lead to a destabilizing posture of mutual conditional survival from ballistic missile attack, even if the strategic defenses deployed by the superpowers were totally invulnerable.[4]

In general, a safe transition would be possible if both sides deployed many weapons at sea and if the number of RVs available for effective attack on the other's land-based forces did not greatly exceed the

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[3]A wide avenue for transition in this context means that each country could ultimately attain an assured survival capability while preventing the other from acquiring a capability for conditional survival.

[4]To the degree that U.S. and Soviet defenses were vulnerable to suppression efforts, a world of mutual conditional survival would become more likely. The extreme case would occur, of course, if both superpowers deployed highly vulnerable defenses. In this situation, neither U.S. nor Soviet assured survival would be possible.

number of aim points on which those RVs were based.[5] **It is demonstrated that the most important actions that the superpowers could take to facilitate a stable transition include:**

- **Placing sustained and comprehensive constraints on ballistic missile RVs and throwweight** in an effort to limit or reduce each side's counterforce capability.
- **Unilaterally implementing force survivability measures to increase the number of aim points,** for example, by deploying ICBM RVs in redundant silos and/or on hardened mobile launchers that could move about in large basing areas.
- **Increasing the number of RVs at sea.**

The defense-potential analysis of the ballistic missile portion of the transition to nationwide strategic defenses suggests the following conclusions:

- **The United States should not seek to amend the 1972 antiballistic missile (ABM) treaty with the aim of deploying local defenses to increase the number of RVs on intercontinental ballistic missiles (ICBMs) likely to survive a Soviet attack. The deployment of local defenses to protect U.S. ICBM sites would contribute only marginally to a stable transition to assured survival.**

The current Soviet ballistic missile force contains a relatively large number of RVs capable of hard target kill, while the current U.S. ballistic missile force has a relatively small number of aim points. Thus, even fairly large deployments of local defenses in the absence of nationwide strategic defenses would not significantly increase the number of U.S. ICBM RVs likely to survive a Soviet first strike.

- **Given current U.S. and Soviet ballistic missile forces, the symmetrical deployment of intermediate levels of strategic ballistic missile defenses would erode the U.S. ballistic missile deterrent and decrease first-strike stability.**

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[5]The Soviets currently deploy approximately 6000 RVs on intercontinental ballistic missiles (ICBMs), 5000 of which are capable of effectively attacking the 1000 U.S. ICBM silos. The Soviets thus enjoy an overkill capability with respect to U.S. ICBM silos. The United States, in contrast, has barely one effective RV for each Soviet ICBM silo. The United States today has a total of roughly 2000 ICBM RVs, of which approximately 1500 can be considered hard target killers capable of effectively attacking some 1400 Soviet ICBM silos.

From the U.S. perspective, intermediate levels of symmetrical ballistic missile defenses would deny the United States a ballistic missile counterforce option without really protecting the U.S. population or strategic forces from a Soviet ballistic missile attack. From the Soviet perspective, modest levels of symmetrical superpower ballistic missile defenses would allow the USSR to deny the United States a ballistic missile counterforce option while not significantly detracting from the Soviet counterforce option.

As a net result of a symmetrical deployment of intermediate levels of defense, the Soviets would dangerously approach a capability to draw down with their own offenses U.S. weapons on ICBMs and submarine-launched ballistic missiles (SLBMs) in port. The Soviets could then use their defenses to stop surviving U.S. ballistic missile RVs launched in retaliation. They might even be able to limit the damage to the Soviet Union from a U.S. retaliatory attack involving only ballistic missiles to such an extent that, at least in the eyes of U.S. strategists, they might deem the damage acceptable.

- **During the period when U.S. ballistic missile retaliatory capability was eroding, the United States would have to depend heavily on strategic bombers and bomber weapons (gravity bombs and cruise missiles) to deter the Soviets.**
- **Given present-day U.S. and Soviet ballistic missile forces, the United States would have to deploy ballistic missile defense capability at a much faster pace than the Soviet Union to guarantee a stable transition to assured survival from ballistic missile attack.**
- **Finally, the United States must redress the existing asymmetry in ballistic missile force capability through arms control and/or the modernization of basing modes of existing forces, or it must prepare to build and deploy strategic ballistic missile defense capability nearly twice as fast as the Soviet Union builds and deploys its strategic defenses.**

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I. INTRODUCTION

On March 23, 1983, President Reagan delivered a nationally televised address that would fundamentally affect both U.S. and allied security policy and superpower relations. Since the advent of nuclear weapons, the President said, the U.S. deterrent has relied solely on the specter of offensive retaliation. He proposed, therefore, that the United States embark on a program to explore defensive measures in the hope that such measures would provide a stable basis for our security. The following passage from the President's statement best captures the program's strategic defense goals:

> What if free people could live secure in the knowledge that their security did not rest upon the threat of instant U.S. retaliation to deter a Soviet attack, that we could intercept and destroy strategic ballistic missiles before they reached our own soil or that of our allies?[1]

The President's question underscored the fact that, although the United States has deterred a Soviet attack for 35 years by maintaining a capability to inflict severe damage on the Soviet Union even after an all-out, would-be-disarming Soviet first strike, in the final analysis U.S. national survival has depended on the restraint and forbearance of the Soviets in a crisis. In other words, the United States does not fully control its own destiny: U.S. survival ultimately depends on the restraint of Soviet leaders and their calculus of gains and risks.

The successful development and deployment of strategic defenses would enable the United States to ensure its own *national survival*, even in the event of an all-out Soviet first strike.[2] This goal, called *assured survival* in this report, is defined as the capability of one country to survive the other country's first strike with ballistic missiles. The transition from the current U.S. posture of no nationwide defense to one in which U.S. defenses were robust enough to ensure the survival of this nation may take many years. It will certainly present many difficulties along the way.

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[1]President Ronald Reagan, "Address to the Nation, 23 March 1983," *Weekly Compilation of Presidential Documents*, Vol. 19, No. 12, U.S. Government Printing Office, Washington, D.C., 1983, p. 447.

[2]The exact nature of national survival in the event of a war involving nuclear weapons is open to question. Although the detonation of even one nuclear weapon on U.S. territory could be a catastrophe, the United States would survive as a nation. Much further critical study is needed to determine the number of nuclear detonations the United States could withstand and still survive. This number might well be as high as a few tens of weapons.

This report details the anatomy and calculus of the transition to the stated goal of U.S. (and perhaps Soviet) assured survival from ballistic missile attack. We make no judgments as to whether either superpower is technically capable of deploying nationwide defenses with such high intercept potentials and low inherent leak rates as to provide assured survival. We assume in the analysis and discussion that both sides would have the capability to achieve assured survival if they so chose, and we then examine the issues surrounding the transition to that posture.

To make the analysis as straightforward as possible, we present, and discuss in detail, a series of figures showing what the transition would look like if we made specific assumptions about the superpower offensive and defensive force postures. An appendix to the report gives the technical details of operating modes for ballistic missile defenses.

To provide insight into policy issues surrounding a transition to assured survival, the report develops a broad analytic framework—which we call the *defense-potential* format—based on the following three generic forces:

- Strategic offensive forces
- Strategic defensive forces
- Strategic defense-suppression forces.[3]

This format can be used to demonstrate which postures of these three types of forces would provide the United States the capability sought by the President and which conditions would ensure a safe and stable transition from no nationwide defense to effective strategic defenses.

In the offensive-dominant world of today, both superpowers possess roughly comparable strategic nuclear attack capabilities. This approximate parity results from a series of offsetting asymmetries. The United States enjoys an advantage in regard to the overall number of strategic weapons deployed, the number of ballistic missile reentry vehicles (RVs) on submarines at sea, and the number of gravity bombs and cruise missiles carried by long-range aircraft. The Soviets have greater ballistic missile throwweight, more intercontinental ballistic missile (ICBM) RVs, and superior strategic air defense.

As a result of each side's fielding diverse strategic offensive forces, a U.S. defined condition of first-strike stability is said to exist: That is, neither superpower could execute a first strike against the other's

[3]Strategic defense-suppression forces have been accorded the same level of importance as strategic offensive and defensive forces to underline our belief that in a future era of effective nationwide defenses, defense-suppression forces will assume much more prominence and, indeed, may become the dominant force.

forces that would either decisively shift the strategic balance in the attacker's favor or preclude the possibility of his suffering massive retaliatory damage.

Despite the fact that the United States and the Soviet Union deploy diversified strategic forces, we purposely restrict the analytic format employed in this report to intercontinental-range ballistic missiles and strategic nationwide ballistic missile defenses. We omit bombers and bomber defenses for several reasons.

First, the President clearly indicated that at least the initial stages of the defense research program should focus on counteracting Soviet ballistic missiles capable of striking American territory. Hence, we assume throughout the report that strategic nationwide ballistic missile defenses consist of several layers, the most significant being the space-based battle stations capable of intercepting ballistic missiles in the boost-phase portion of their flight.

Second, by not including bombers and bomber defenses, we can better illustrate the effect of ballistic missile defenses on U.S. and Soviet first-strike and ballistic missile retaliatory capabilities. For example, by focusing solely on ballistic missiles and ballistic missile defenses, we can pinpoint the U.S. and Soviet force postures that would sharply reduce U.S. ballistic missile retaliatory capability from today's level of roughly 3000 RVs.

If its ballistic missile retaliatory capability were to deteriorate, the United States would have to rely more heavily on its bomber force than it now does to maintain a credible deterrent. If, in these same conditions, our analytic format had included bombers and kept track only of U.S. retaliatory capability, it might have made the U.S. deterrent continue to appear credible, without ever indicating that a significant shift toward almost sole reliance on bombers had occurred.

Finally, should the United States and the Soviet Union decide to undertake the transition to assured survival with regard to ballistic missiles, each might eventually also deploy effective defenses against bombers and cruise missiles. However, defenses against air-breathing attack systems need not proceed in lockstep with ballistic missile defenses. In fact, as will be shown below, first-strike stability is served if, in the transition, bomber defense capabilities are allowed to lag significantly behind ballistic missile defense capabilities.

Although the United States would remain vulnerable to other means of attack, including nuclear weapons carried on air-breathing systems, such as bombers and cruise missiles, the achievement of assured survival from ballistic missile attack could nevertheless enhance U.S. security. Effective defenses could, in the first place, ensure U.S. survival against ballistic missile attack, whether accidental or intentional.

Moreover, effective defenses could preclude Soviet options for successfully attacking U.S. strategic nuclear forces, theater projection forces, and other targets. If, because of the reduced utility of ballistic missiles, the Soviets were forced to employ slower-flying, presently less-capable bombers and cruise missiles in an attack on U.S. assets, the United States presumably would have more time to react to the warning of a Soviet attack and to respond appropriately.

II. ANALYZING THE TRANSITION TO ASSURED SURVIVAL

DEFENSE-POTENTIAL FORMAT

To analyze the interaction of U.S. and Soviet strategic offensive, defensive, and defense-suppression forces using the defense-potential format, we must make specific assumptions about the capability and deployment posture of each side's three generic forces. Each figure in this section therefore contains the following data on the number, character, and basing mode of U.S. and Soviet strategic forces:

- Total number of U.S. and Soviet ballistic missile RVs on station,[1] including
  - — Subtotals of ICBM RVs and SLBM RVs at sea
  - — Number of ICBM silos
  - — Number of hard-target kill-capable (killer) RVs and their probability of kill against an enemy silo.
- Operating mode and vulnerability of ballistic missile defenses.
- Effectiveness and vulnerability of defense-suppression forces.

Most of the figures are based on the assumption that the U.S. and Soviet nationwide defensive forces are invulnerable to any efforts to suppress them. In other words, strategic defense-suppression forces are assumed to be ineffective.

The operating mode of U.S. and Soviet nationwide defenses describes how the defender would subtract out RVs from an enemy attack. Strategic nationwide defenses could, at least conceptually, operate in several different modes.

The *pure random subtractive* strategic defense operating mode would require the least amount of knowledge about the character of the enemy's attack. In this mode, a defense would simply subtract out RVs from an enemy attack without regard to the type of RV (killer versus nonkiller) or its intended target.

If a defender could discriminate killer from nonkiller RVs by determining from which silos they had been launched and could then

[1]Only ICBM and submarine-launched ballistic missile (SLBM) RVs on alert status on a given day are considered to be on station. In this analysis, we assume nearly all U.S. and Soviet ICBM RVs to be on station. Roughly 60 percent of U.S. and 30 percent of Soviet SLBM RVs are assumed to be on station; SLBM RVs on nuclear-powered ballistic missile submarines (SSBNs) in port are not considered to be on station.

preferentially attack the killers, the defense would be operating in the *discriminating random subtractive* mode. We assume this operating mode for U.S. and Soviet strategic nationwide defenses in all but one of the figures in this section.[2]

Strategic ballistic missile defenses might also be operated so as to preferentially defend certain targets, for example, command and control nodes of the defense itself. This type of defense might be either *semipreferential* or *complete preferential*; both are discussed in the Appendix.

The actual U.S. and Soviet level of deployed strategic nationwide defense is shown in the figures as a free-running variable along the x- and y-axes, respectively, and is described in terms of *defense potential*, or the number of RVs a defense could extract from a particular enemy attack.

The *intercept potential* of a given ballistic missile defense network is determined by:

- The number and capability of battle stations in the constellation and whether these stations were positioned to intercept enemy missiles in their boost, postboost, mid-course, or terminal stages of flight
- The character of the enemy attack (including such factors as the number of RVs, the number and type of missile boosters, and whether the missiles were launched from many sites spread out over a large area or from a few concentrated sites)
- The extent and effectiveness of decoys.

If the United States and the Soviet Union were to deploy an equal number of similarly capable battle stations, given current superpower ballistic missile forces, the U.S. defense would probably have a higher defense potential than the same Soviet defense, owing to the following factors:

- The Soviet ballistic missile force still consists largely of liquid-fueled missiles, which are more vulnerable to interception.

[2]At present, all U.S. and Soviet hard-target killers are land-based in fixed and known locations. Given this feature, it is not unreasonable to assume that space-based defenses, when overlayed on existing U.S. and Soviet forces, could discriminate enemy killer RVs from nonkillers. One should note, however, that this assumption would break down somewhat if each side were to deploy large numbers of killers on land-based mobile launchers or submarines at sea. The defender might have little, if any, prior position information and might have difficulty distinguishing the signature of different boosters. In this event, the operating mode of nationwide defenses would more closely resemble pure random rather than discriminating random subtractive.

- Soviet ballistic missile deployments are spread out over a larger geographic area than U.S. deployments, allowing more U.S. battle stations to be on line during an attack and capable of intercepting Soviet boosters.

Complicated computer models can determine the exact number of RVs that the postulated defensive constellation could extract from a postulated attack.[3] The output determines where to enter the abscissa (U.S. defense potential against a Soviet attack) and the ordinate (Soviet defense potential against a U.S. attack).

If the United States possessed a defense potential (in RVs) that equaled or exceeded the number of Soviet RVs on station (7000) and if the inherent leak rate of these defenses were small, then, by definition, the United States would have an assured survival posture (capability). If the Soviets' defensive capability equaled or exceeded the number of U.S. RVs on station (5000) and if the leak rate of the Soviet defense were sufficiently small, the Soviets would enjoy a posture of assured survival. Mutual assured survival would exist if both the United States and the Soviet Union had assured survival.

The level of defense required by either side to attain an assured survival capability would not depend on the operating mode of that defense. To attain this capability, the U.S. or Soviet defense would have to be capable of subtracting out nearly all of the attacking enemy RVs, regardless of where they were targeted and whether they were killers or nonkillers.

In other words, in determining whether a country possessed an assured survival capability, it would not matter whether that country's defenses were capable of preferentially defending certain targets or preferentially attacking certain RVs. In fact, the defense would defend whatever targets were being attacked. All that mattered would be whether these defenses could intercept nearly all of the attacking RVs.

In summary, the defense-potential format handles the three generic forces by (1) showing the capability of defense-suppression forces, the number and character of offensive forces, and the operating mode of the strategic defensive forces and (2) treating defensive capability as a free variable expressed in terms of defense potential. We can now begin to examine the circumstances under which the interaction of these forces provides the United States and Soviet Union certain capabilities.

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[3]See, for example, Herbert G. Hoover and Michael D. Miller, *The Relationship Between Threat Size and Required Constellation Size for Ballistic Missile Defense*, The Rand Corporation, N-2404-SDIO, 1986.

BASE CASE: CURRENT STRATEGIC OFFENSIVE AND NOTIONAL STRATEGIC DEFENSIVE FORCES

Figure 1 illustrates assured survival within the defense-potential format. The figure roughly approximates current U.S. and Soviet strategic offensive forces as follows: The United States has 2000 ICBM RVs in 1000 silos and 3000 SLBM (nontargetable) RVs at sea, for a total of 5000 on-station RVs. The Soviets have 7000 on-station RVs, thanks mainly to their large ICBM force of 6000 RVs in 1400 silos. Moreover, the Soviet Union has substantially more counterforce capability than the United States.[4]

The Soviets are assumed to have deployed 5000 killer RVs on their SS-18 and SS-19 ICBMs, each with a 0.7 P_k against a U.S. ICBM silo. Given that the United States has only 1000 such silos, one can see that the Soviets possess an overkill capability against U.S. ICBM silos. Moreover, it is assumed that the United States has only 1500 killer RVs with which to attack 1400 Soviet silos, and each RV has only 0.4 P_k.

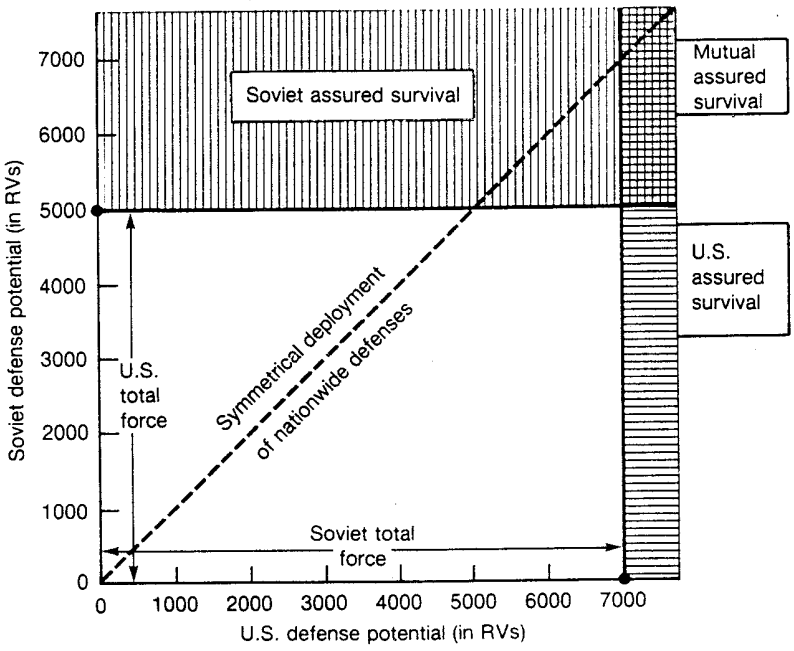
The graph in Fig. 1 is a square. Inside the square is a rectangle defined by the number of Soviet RVs on station (7000) and the number of U.S. RVs on station (5000). A line of symmetrical defense potential describes the locus of points where the United States and the Soviet Union would have equal strategic nationwide defense potential; if the United States had a defense potential of 3000, the Soviets, by definition, would also have a defense potential of 3000.

Figure 1 graphically displays the capabilities defined above. In this case, if the Soviets had a defense potential of 5000 and if these defenses had a low inherent leak rate, the Soviets could ensure, through defensive means alone, that the Soviet nation could survive a U.S. first strike with ballistic missiles.

Another, perhaps more relevant, scenario to examine would involve both Soviet offensive and defensive forces. In this scenario, the Soviets would use their offensive weapons to execute a counterforce attack against U.S. offensive forces and their defenses to intercept any surviving U.S. RVs that were launched in retaliation. Of course, the same type of scenario could also be applied to the United States.

Before displaying the results of these two scenarios, given current strategic offensive forces, we briefly address the effects of each

[4]Data on the numbers, types, and capabilities of U.S. and Soviet strategic offensive forces are notional, based on U.S. Department of Defense, *Soviet Military Power 1985,* U.S. Government Printing Office, Washington, D.C., April 1985; U.S. Congress, Congressional Budget Office, *Modernizing U.S. Strategic Offensive Forces: The Administration's Program and Alternatives,* 1983; and International Institute for Strategic Studies, *The Military Balance 1985–1986,* London, 1985.



DATA (Notional)

- Nationwide defenses operate in discriminating random subtractive mode and are invulnerable to suppression
- U.S. Force: 5000 on-station RVs, including
  - 2000 ICBM RVs in 1000 silos, of which 1500 RVs are killers with 0.4 P_k against Soviet silos
  - 3000 nontargetable RVs
- Soviet Force: 7000 on-station RVs, including
  - 6000 ICBM RVs in 1400 silos, of which 5000 RVs are killers with 0.7 P_k against U.S. silos
  - 1000 nontargetable RVs

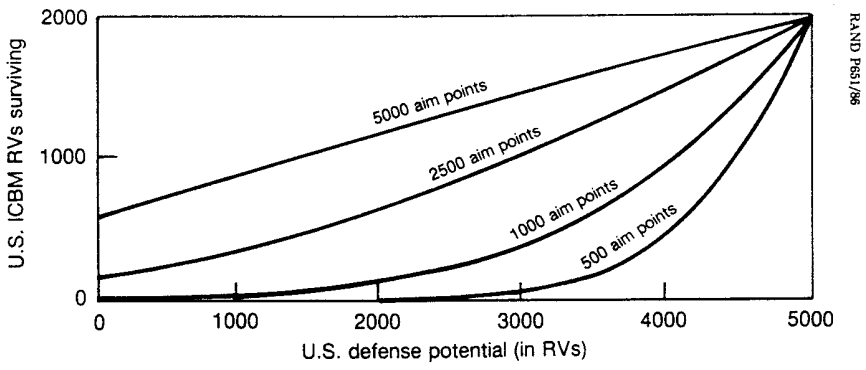
Fig. 1—Assured survival in defense-potential format, given current offensive forces

superpower's attack on the other's ICBM force in the presence of varying amounts of nationwide defense potential, starting first with a Soviet attack on the U.S. ICBM force.

Effects of Strategic Defense and Aim Points on U.S. ICBM Survivability

Figure 2 displays how the number of U.S. ICBM RVs surviving a Soviet attack would vary with the capability of U.S. nationwide defenses and the number of U.S. aim points. We assume that the United States has deployed 2000 ICBM RVs and the Soviets 5000 killer RVs, each having a 0.7 P_k against a U.S. Minuteman silo. (This is very roughly the number and capability of RVs on present-day Soviet SS-18s and SS-19s.)

The Soviet attack strategy in this scenario is to destroy as many U.S. RVs as possible with a given expenditure of their 5000 killers. At low levels of U.S. defense potential, the Soviets would need only to attack U.S. ICBMs with a fraction of their total killer RVs to obtain high damage expectancies; they could then hold the remainder in reserve or use them to target other hardened U.S. assets, such as C^3 nodes or ICBM launch control centers.



DATA (Notional)

- U.S. Defense Potential: Nationwide defenses operate in discriminating random subtractive mode and are invulnerable to attack
- U.S. ICBM Deployment: 2000 RVs in various numbers of aim points
- Soviet ICBM Attack Force: 5000 RVs with 0.7 P_k against U.S. Minuteman silos

Fig. 2—Relationship between U.S. ICBM survivability and number of aim points under discriminating strategic defense

Figure 2 indicates the results of a Soviet attack if the 2000 U.S. ICBM RVs were deployed in various numbers of aim points, ranging from 500 to 5000. If, as is currently the case, the United States had its ICBM RVs deployed in 1000 aim points and no nationwide ballistic missile defense potential, none of these RVs would be likely to survive a Soviet attack of 5000 killer RVs. If the U.S. defenses operated in a discriminating random subtractive mode and had a defense potential that equaled (or exceeded) the total number of Soviet killers (5000), then all the U.S. Minuteman RVs (2000) would, by definition, survive.

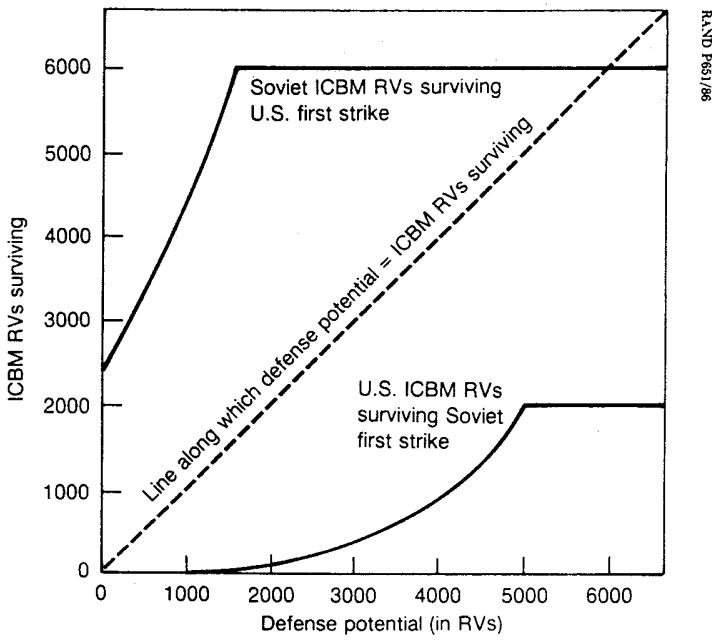
Until the United States deployed fairly robust strategic defenses, only a small number of U.S. ICBM RVs would survive the Soviet attack. For example, if the U.S. defense potential were 2500 (one-half the Soviet attack potential of 5000) and the U.S. ICBM force were deployed in 1000 aim points, only some 10 percent of the U.S. Minuteman force would survive a Soviet attack of all 5000 killers. This low survival rate would result from the Soviet overkill capacity of 5000 RVs to attack 1000 silos—a ratio of 5 to 1.

Thus, for the current case, in which the United States ICBM force is deployed in 1000 U.S. aim points, strategic nationwide defenses approaching the total Soviet attack potential of 5000 RVs would be required to significantly increase the number of U.S. ICBM RVs likely to survive a Soviet attack.

If, however, the United States were to deploy its 2000 ICBM RVs in 2500 aim points, the deployment of nationwide defenses would pay off immediately. Now, if the U.S. defenses could randomly subtract out half the Soviet killer RVs, nearly 40 percent of U.S. ICBM RVs would survive. In the case of 5000 U.S. aim points, U.S. defenses with a potential to intercept 2500 Soviet RVs could ensure the survival of 60 percent of the U.S. ICBM force. In both instances, the U.S. addition of aim points served to erode the Soviet overkill capacity, thus allowing low to modest levels of nationwide defense to make a real difference in terms of U.S. ICBM RVs surviving a Soviet attack.

Comparison of U.S. and Soviet ICBM Survivability in Presence of Strategic Defenses

Figure 3 is similar in most respects to Fig. 2. The format is identical, and the curve labeled "U.S. ICBM RVs surviving Soviet first strike" is the same as the "1000 aim points" curve in Fig. 2. We have now added a curve displaying surviving Soviet ICBM RVs if the United States were to strike first. Unlike the case of surviving U.S. ICBM RVs after a Soviet first strike, some of the 6000 Soviet ICBM RVs survive the U.S. first strike, even with no Soviet defense. They survive



DATA (Notional)

- Nationwide defenses operate in discriminating random subtractive mode and are invulnerable to attack
- U.S. ICBM Force: 2000 RVs in 1000 silos, of which 1500 RVs are killers with 0.4 P_k against Soviet silos
- Soviet ICBM Force: 6000 RVs in 1400 silos, of which 5000 RVs, located in 650 silos, are killers with 0.7 P_k against U.S. silos

Fig. 3—Comparison of U.S. and Soviet ICBM survivability in presence of strategic defense

because the United States is attacking 1400 Soviet silos with only 1500 killer RVs, a ratio of attacker to aim points only marginally greater than one. Moreover, a U.S. killer RV is assumed to have a P_k of only 0.4 against a Soviet silo.

If the Soviet ICBM deployments were uniform and each silo contained about four RVs, then, in round numbers, slightly more than one-half, or nearly 3300, of the 6000 RVs would survive for the case of no Soviet strategic defense. Actually fewer Soviet RVs would survive because some of the Soviet silos would be assumed to contain 10 RVs and others 6 RVs, and the more lucrative targets would be

preferentially attacked. Thus, nearly 3500 Soviet ICBM RVs could be destroyed by the U.S. counterforce attack.

Most important, if the Soviets were to deploy nationwide defenses (operating in a discriminating random subtractive mode) with a potential to intercept 1500 RVs or more, they could stop essentially all of the U.S. killers. All 6000 of their ICBM RVs would survive.

One can see in Fig. 3 how the considerable asymmetry in the posture of the strategic offensive ballistic missile forces of the two countries is magnified in the presence of strategic defenses. The United States is defending a few ICBM RVs (2000) from an attack of many Soviet killer RVs (5000). In contrast, the Soviets are defending many ICBM RVs (6000) from an attack of few U.S. RVs (1500).

If current U.S. and Soviet SLBM forces were added to this picture and if neither country possessed defenses, around 3500 Soviet RVs (2500 surviving ICBM RVs plus 1000 nontargetable SLBM RVs) would survive a U.S. first strike in the absence of any Soviet strategic defense. In contrast, some 3000 U.S. RVs (all nontargetable SLBM RVs at sea) would survive a Soviet first strike in the absence of any U.S. nationwide defense.

If each side were to deploy nationwide defenses with a potential to preferentially intercept 3000 RVs and if the United States were to strike first, the Soviet defense would be more than adequate to stop all 1500 U.S. killers and all 6000 Soviet ICBM RVs survive. The total of Soviet RVs likely to survive the U.S. attack and penetrate the U.S. defense is then 4000 (6000 ICBM RVs plus 1000 RVs at sea minus the 3000 lost to U.S. defenses). As a result of the deployment of U.S. and Soviet nationwide defenses at this level, Soviet ballistic missile retaliatory capability increased from 3500 RVs to 4000 RVs.

The U.S. case is quite different. In the event of a Soviet first strike, the U.S. defense potential would not suffice to overcome the overkill potential of the 5000 Soviet killers. Despite the presence of U.S. strategic defenses capable of intercepting 3000 Soviet RVs, very few U.S. Minuteman ICBM RVs survive. The total number of U.S. RVs that could survive the Soviet attack and penetrate the Soviet defense would be reduced from 3000 RVs to about 300 RVs (approximately 300 to 400 surviving Minuteman RVs plus 3000 RVs at sea minus 3000 RVs lost to the Soviet defenses).

If each side deployed a defense potential of 5000, the Soviet Union would continue to hold the advantage. Some 2000 Soviet RVs (6000 ICBM RVs plus 1000 SLBM RVs minus 5000 RVs subtracted out by U.S. defenses) could survive and penetrate. Almost no U.S. RVs (2000 ICBM RVs plus 3000 SLBM RVs minus 5000 RVs subtracted by Soviet defenses) would survive and penetrate.

Owing to the current asymmetry of the posture of offensive forces, then, the Soviets would profit greatly from initial and intermediate deployments of nationwide defenses. Thus, if the ballistic missile force asymmetry remained unchanged and if the United States should decide to undertake a transition to a posture of assured survival, it must be prepared from the start to deploy defense potential at a much faster pace than the Soviets to maintain deterrence. More will be said of this later.

Conditional Survival

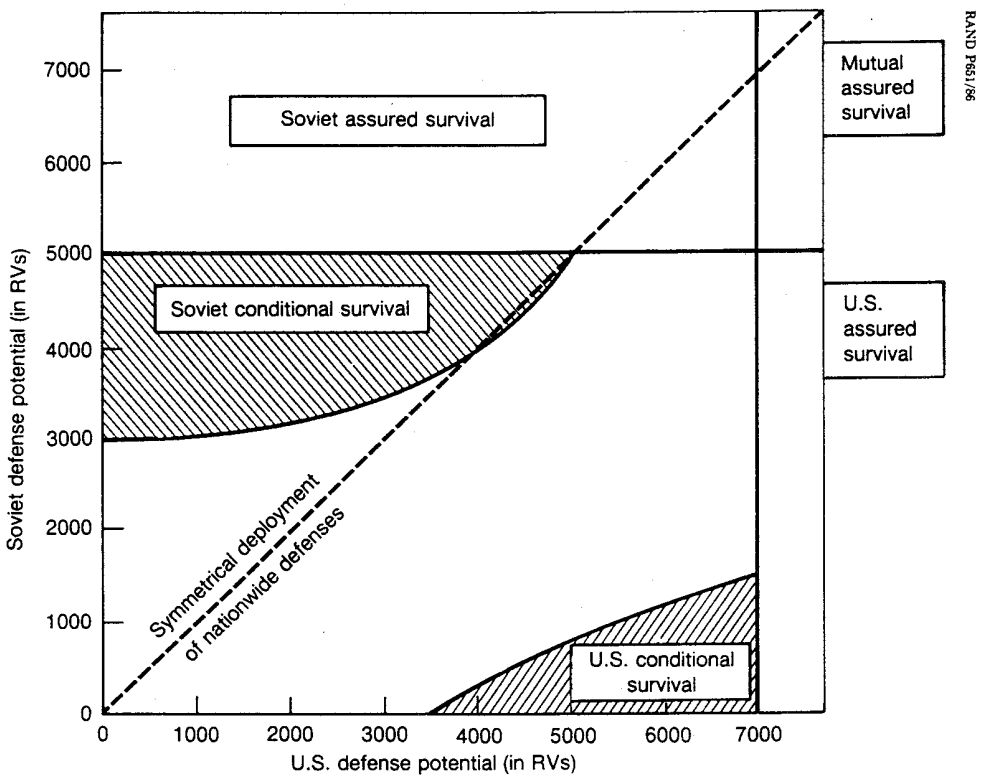
Figure 1, above, dealt with assured survival of an enemy first strike with ballistic missiles—"assured" in the sense that the survival of the nation did not depend on the restraint and forbearance of the adversary in a crisis. Rather, national survival was assured solely by nationwide defenses, which would protect the United States even if the enemy engaged in an all-out, surprise ballistic missile attack.

Figure 4 examines the case of conditional survival—the capability to survive the adversary's ragged ballistic missile retaliatory attack after one's own first strike with ballistic missiles. In this sense, survival is conditional—a country survives on the condition that it launches a first-strike counterforce attack and has sufficient defenses to enable it to survive the other's ballistic missile retaliatory attack.

The calculation as to how much defense would be required to attain conditional survival against ballistic missile attack would depend solely on the perception of the potential aggressor. For example, if the Soviets were considering launching a first strike, a primary consideration in such a decision would have to be the number of U.S. ballistic missile RVs likely to survive an attack and reach Soviet territory.

Figures 2 and 3, above, showed that without any U.S. nationwide defenses, no U.S. ICBM RVs would survive a Soviet first strike. If the Soviets were capable of defending their nation against the remaining U.S. ballistic missile RVs (3000 U.S. RVs on SLBMs at sea), they would possess the operational capability termed conditional survival; i.e., few, if any, U.S. ballistic missile RVs would survive a Soviet attack and penetrate to Soviet territory.[5]

[5]Actually, the Soviets could not have a posture of conditional survival, or even of assured survival, unless quite effective bomber defenses accompanied their ballistic missile defenses. As stated earlier, this calculus addresses only defenses against ballistic missile RVs; it does not explicitly treat defenses against bomber weapons. It is important to treat these matters separately. The closer the Soviets come to reducing to zero the number of U.S. ballistic missile RVs that survive and penetrate, the greater the burden on the U.S. bomber force to sustain the U.S. deterrent and thus the greater U.S. vulnerability.



DATA (Notional)

- Nationwide defenses operate in discriminating random subtractive mode and are invulnerable to suppression
- U.S. Force: 5000 on-station RVs, including
  - 2000 ICBM RVs in 1000 silos, of which 1500 RVs are killers with 0.4 P_k against Soviet silos
  - 3000 nontargetable RVs
- Soviet Force: 7000 on-station RVs, including
  - 6000 ICBM RVs in 1400 silos, of which 5000 RVs are killers with 0.7 P_k against U.S. silos
  - 1000 nontargetable RVs

Fig. 4—Base case I: operational capabilities, given current U.S. and Soviet ballistic missile forces and discriminating strategic defenses

So, if the United States had no strategic nationwide defenses and the Soviets had nationwide defenses with a potential to intercept slightly more than 3000 RVs with a very low leak rate, the Soviets would be on the border of a conditional survival capability—at least as far as ballistic missiles are concerned.

If the United States deployed its own defenses, the Soviet attack against U.S. Minuteman silos would be blunted to some extent. Some Minuteman ICBM RVs would survive, and the Soviets would have to deploy more defenses to handle this larger U.S. ballistic missile retaliatory attack. If the United States deployed sufficient defenses to stop all 5000 Soviet killers, all 2000 Minuteman RVs would survive. To attain a conditional survival capability from U.S. ballistic missile attack now, the Soviets would need a defense potential of 5000 RVs to stop 2000 U.S. ICBM RVs plus 3000 U.S. SLBM RVs.

The area of Soviet conditional survival in Fig. 4 is determined by the effectiveness of the Soviet counterforce attack in the presence of varying levels of U.S. defense. In this case, the curve of the conditional survival area matches the Soviet first-strike curve in Fig. 3. The extended bow of the curve stems from the Soviet overkill capacity against U.S. ICBMs. The United States would have to deploy quite robust U.S. defenses (with potential to intercept over 3000 RVs) to significantly increase the number of surviving Minuteman ICBM RVs and to force the Soviet conditional survival curve upward.

The curve of U.S. conditional survival from Soviet ballistic missile attack, like the Soviet curve, matches the corresponding curve in Fig. 3. The U.S. conditional survival area is much smaller than the Soviet, because the United States lacks an overkill capability against enemy ICBMs.[6] If the Soviets had not deployed any defenses, then a U.S. defense potential of roughly 3500 RVs would equal the Soviet retaliatory attack of 3500 RVs (2500 Soviet ICBM RVs plus 1000 SLBM RVs at sea). However, as the Soviets deployed defenses, the number of surviving Soviet ICBM RVs would increase rapidly and the United States would have to deploy more robust strategic nationwide defenses to

[6]The assumption implicit throughout this analysis is that neither side launches its ICBMs out from under the other's attack. If we change this assumption and allow for prompt retaliatory launch, the aggressor's first strike would destroy very few if any enemy ICBMs. The RVs from the enemy's targetable and nontargetable forces would be launched at the attacker. To survive, the attacker's defenses would have to intercept almost every RV in the other side's total inventory. In the framework used here, prompt retaliatory launch would make the areas of conditional survival disappear. Figure 1, above, with only assured survival areas, is then also the appropriate representation of a world in which each side believes that the other would launch its warheads upon receiving warning of an attack. It is interesting to note the existence, in this world of launch under attack, of a wide avenue of transition to assured survival.

retain the capability for conditional survival. This effect was demonstrated in Fig. 3, above.

As noted above, the areas of conditional survival pertain only to ballistic missiles and ballistic missile defenses that consist primarily of space-based components. Any point along, or inside, the Soviet conditional survival curve represents a situation in which the defense potential of Soviet defenses would equal or exceed the number of U.S. ballistic missile weapons that would survive a Soviet first strike.

Even if the Soviets were to deploy a nearly perfect defense against U.S. ballistic missiles, strategic bombers armed with cruise missiles and gravity bombs—the third leg of the U.S. triad—might still be able to deter the Soviets from attacking the United States or its allies. Unless the Soviets deployed air defenses equal in effectiveness to their defense against ballistic missiles, U.S. retaliatory capability would still consist of up to several thousand weapons.

Thanks to these U.S. weapons, the Soviets would continue to lack an incentive to launch a first strike. In this sense, first-strike stability in a transition to a defense dominant world might be preserved by the failure of Soviet defenses against air-breathing systems to keep pace with their ballistic missile defenses.

In any transition from essentially no nationwide ballistic missile defenses to quite effective defenses capable of providing an assured survival capability, each superpower must strive to stay as far as possible from the other's area of conditional survival. Neither the United States nor the Soviet Union could feel secure if its ballistic missile retaliatory capability had been reduced to zero and it had to depend entirely on bombers for its deterrent. Thus, each side would want the other's area of conditional survival to be small so as to avoid the situation described above.

The size and shape of each side's area of conditional survival, as noted above, is determined by the effectiveness of its first strike against the other's strategic offensive forces. For example, the greater the number of U.S. RVs that survive a Soviet attack at each level of U.S. defense potential, the more robust Soviet defenses must be to intercept them and, consequently, the smaller the area of Soviet conditional survival.

The relationship between the survivability of the U.S. offensive forces and the size of the Soviet area of conditional survival has two rather important implications. First, once the number and character of Soviet killer RVs had been established, the United States would control the shape of the Soviet conditional survival curve. In other words, through a variety of means, the United States would directly determine the shape of the Soviet area of conditional survival. (As we shall see

later, these U.S. measures would include the posture of U.S. offensive forces, the operating mode of its nationwide defenses, and the deployment of local ICBM defenses.) The same relationship would govern Soviet force survivability and the U.S. conditional survival area.

Second, while Fig. 3, above, demonstrated that the U.S. deployment of nationwide defenses for the express purpose of increasing U.S. ballistic missile retaliatory capability might not be appropriate, given current U.S. and Soviet strategic ballistic missile forces, the United States might want the capability to protect its ICBMs with local defenses when and if the decision was made to undertake the transition to assured survival. By defending its ICBMs during this transition, the United States would make a Soviet counterforce attack less effective, thus reducing the area of Soviet conditional survival and facilitating a stable transition.

Figure 4 demonstrates that, given the current posture of U.S. and Soviet strategic offensive forces and strategic defenses operating in a discriminating random subtractive mode, each superpower could transit to assured survival from ballistic missile attack without having to cross the other's area of conditional survival. In other words, a fairly wide zone or avenue lies between each side's area of conditional survival through which a stable transition is possible.[7]

In this instance, owing to the significant asymmetries in current U.S. and Soviet ballistic missile forces as described in Fig. 4, the avenue for a safe transition would not lie along the line of symmetrical deployments of nationwide defenses. Rather, the U.S. deployment of defense potential would have to outpace the Soviet effort by nearly 2 to 1 to provide for a smooth, secure transition.[8]

Much of the discussion that follows will center on how and why certain U.S. actions affect the shape of U.S. and Soviet conditional survival areas. This focus will help us to determine how the U.S. deterrent could best be maintained in the transition to mutual assured survival.

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[7]In Fig. 4, we have overlaid U.S. and Soviet strategic defenses on the current posture of superpower strategic offensive forces. By so doing, we are able to see that an open avenue to assured survival exists and to gain some insight as to what measures would be useful in keeping the transition zone open in the future. With this understanding, U.S. and Soviet policymakers would be able to fashion policies designed to keep this zone open into the next decade when, and if, a decision must be made to undertake such a transition. The authors believe that this approach is far more relevant than accepting some projection of U.S. and Soviet offensive force postures in the 1990s—a projection not necessarily grounded in hard evidence and often based on the assumption that the United States and Soviet Union would not cooperate to keep the transition zone open.

[8]The actual path followed by the transition to assured survival could be plotted yearly by determining the amount of U.S. defense potential (entry on the x-axis) and Soviet defense potential (entry on the y-axis). The path would be traced out by connecting these points. The implications of different paths will be addressed in more detail below.

Pure Random Subtractive Defenses

We assume in all figures in this section, except Fig. 5, that each superpower's nationwide defenses operate in a discriminating subtractive mode, i.e., the defenses have the capability to discriminate enemy killer RVs from nonkillers and preferentially subtract out the killers. In Fig. 5 we display what the transition to assured survival would look like if each side's strategic defenses did not have the capability to discriminate killers from other RVs, that is, if the nationwide defenses operated in what we call a pure random subtractive mode. In this mode, the defenses randomly intercept enemy RVs out of the attack, destroying killers and nonkillers alike.[9]

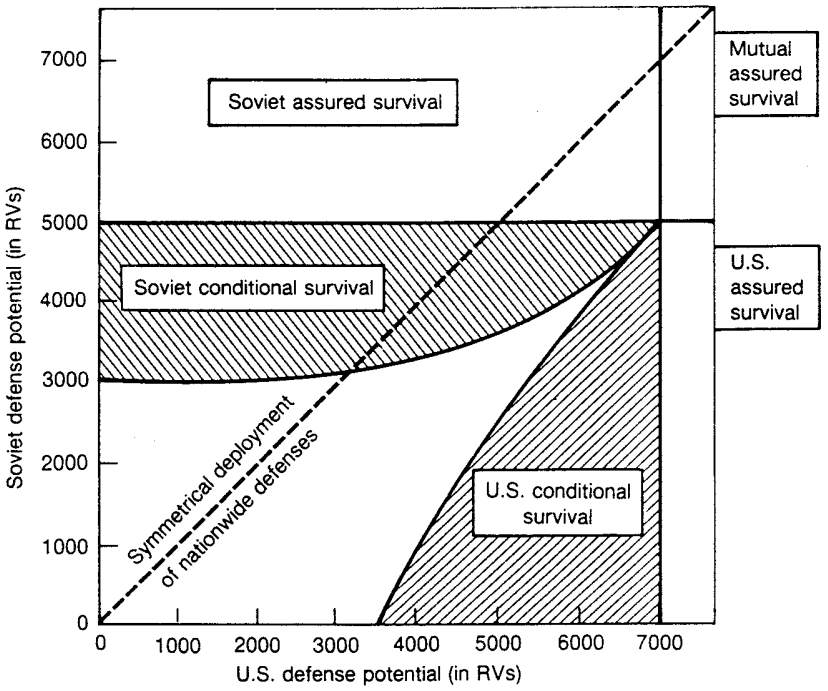
The change in strategic defense operating mode does not affect the shape of the assured survival areas for either the United States or the Soviet Union. Each side must still have a defense potential equal to or greater than the number of enemy ballistic missile RVs on station to attain an assured survival capability. It does not matter if the defense at first preferentially attacks killer RVs or attacks killers and nonkillers alike: Each side must eventually intercept all (or nearly all) RVs to attain the capability of assured survival against ballistic missile attack.

The entry points for U.S. and Soviet conditional survival on the x- and y-axis respectively are also unchanged from the base case in Fig. 4. As noted above, a country has a conditional survival capability if it can survive an enemy's retaliatory attack after its own first strike. The attacker's defenses must again be able to intercept all (or nearly all) surviving RVs, whether killers or nonkillers, to attain this capability.

The failure of the defenses to discriminate between killer and nonkiller RVs would result in the expansion of the U.S. and Soviet conditional survival areas and the concomitant narrowing of the avenue to mutual assured survival against ballistic missile attack. If the U.S. defenses could not discriminate Soviet killer RVs from nonkillers, a defense potential of 5000 would no longer ensure the survival of all U.S. on-station RVs. The U.S. defenses would now subtract 5000 RVs at random from a Soviet attack of 7000 RVs (5000 killers and 2000 nonkillers). Of the 2000 RVs that penetrated U.S. defenses, more than 1400 will be killers targeted against U.S. ICBMs.

Therefore, if U.S. nationwide defenses could operate only in a random subtractive mode, the United States would have to deploy defenses capable of intercepting all (or nearly all) Soviet on-station RVs to ensure the survivability of U.S. on-station RVs. As a result, for a given

[9]See the Appendix for a more detailed discussion of strategic nationwide defense operating modes.



DATA (Notional)

- Nationwide defenses operate in pure random subtractive mode and are invulnerable to suppression
- U.S. Force: 5000 on-station RVs, including
  - 2000 ICBM RVs in 1000 silos, of which 1500 RVs are killers with 0.4 P_k against Soviet silos
  - 3000 nontargetable RVs
- Soviet Force: 7000 on-station RVs, including
  - 6000 ICBM RVs in 1400 silos, of which 5000 RVs are killers with 0.7 P_k against U.S. silos
  - 1000 nontargetable RVs

Fig. 5—Base case II: conditional survival, given current U.S. and Soviet ballistic missile forces and nondiscriminating strategic defenses

level of U.S. defense potential, fewer U.S. RVs would survive the Soviet attack if the defense could not preferentially attack Soviet killers.

In other words, the addition of more and robuster U.S. defenses operating in a random subtractive mode would not enable as many U.S. RVs to survive as would a discriminating defense, and it would only marginally raise the level of Soviet defense required to ensure Soviet survival from a U.S. retaliatory attack. The same applies to the impact of Soviet defenses on Soviet force survivability and the U.S. requirement for defenses.

If the United States and the Soviet Union were to deploy nationwide defenses that could not discriminate killer from nonkiller RVs, the avenue for a transition to mutual assured survival would narrow considerably. At moderate to high levels of U.S. and Soviet nationwide defenses, both sides would come dangerously close to achieving conditional survival, a capability neither could permit the other to possess. This is an extremely unstable area because each side, realizing that it was not far from attaining its own conditional survival capability and that the other was not far from attaining a similar capability, would recognize the high marginal utility of deploying additional defensive or offensive forces.

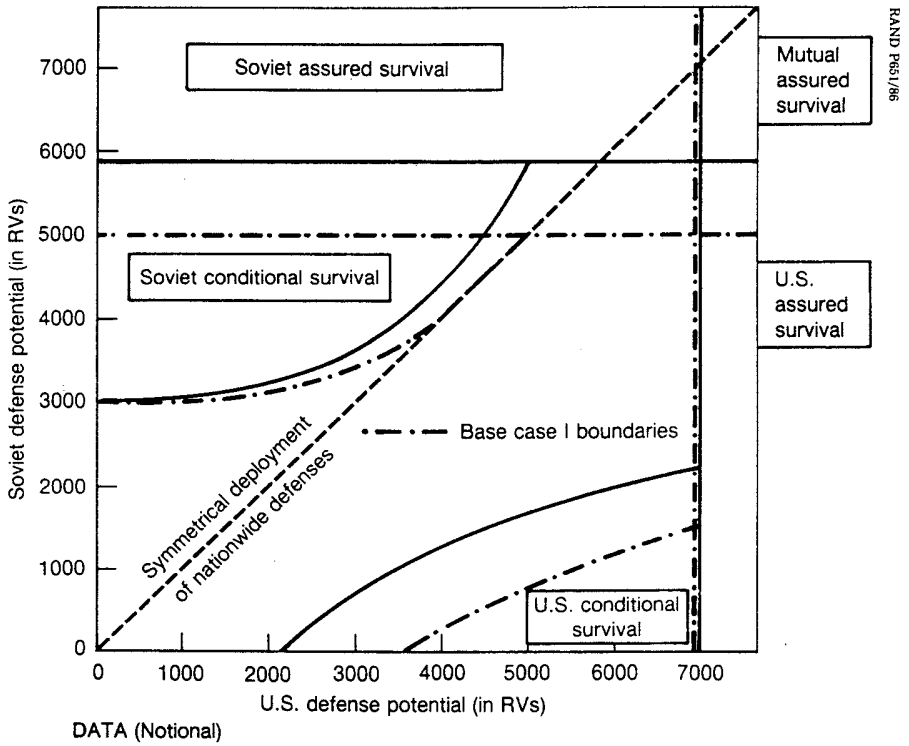
We may draw an important conclusion from Fig. 5: If the United States, in cooperation with the Soviet Union, decides to make the transition to mutual assured survival, it should attempt to deploy nationwide defenses that have the capability to preferentially attack Soviet RVs with hard-target kill capability. If the United States succeeds in this regard, areas of grave instability become much easier to avoid in any transition.

EFFECT ON TRANSITION OF ALTERATIONS IN BASE CASE ASSUMPTIONS

U.S. Deployment of MXs in Minuteman Silos

The deployment of 100 MX missiles (1000 RVs) in 100 Minuteman silos would change the U.S. posture of strategic offensive forces, as indicated in Fig. 6. The United States would have 5700 RVs on station, in contrast to the 5000 RVs in the base case shown in Fig. 4, above. (It is assumed that the 100 MXs would replace 100 Minuteman III missiles carrying 300 RVs.)

The U.S. net addition of 700 on-station RVs would raise the line of Soviet assured survival upward from the base case level of 5000 RVs to 5700 RVs. The curve of Soviet conditional survival would also change, because, by definition, this curve intersects the horizontal line when the United States has a strategic defense potential equal to the number



DATA (Notional)

- Nationwide defenses operate in discriminating random subtractive mode and are invulnerable to suppression
- U.S. Force (with 100 MXs): 5700 on-station RVs, including
  - 2700 ICBM RVs in 1000 silos, of which 2200 RVs are killers, 1200 with 0.4 P_k and 1000 with 0.7 P_k against Soviet silos
  - 3000 nontargetable RVs
- Soviet Force: 7000 on-station RVs, including
  - 6000 ICBM RVs in 1400 silos, of which 5000 RVs are killers with 0.7 P_k against U.S. silos
  - 1000 nontargetable RVs

Fig. 6—Effect on base case I operational capabilities of 100 MX missiles deployed in 100 Minuteman silos

of Soviet killer RVs (5000)—a figure that did not change from the base case. (The base case areas of U.S. and Soviet conditional and assured survival capabilities with present-day force postures are represented by dot-dashed lines. Also, see Fig. 4, above.) The intersection on the ordinate at 3000 also would remain unchanged, because none of the MXs survive for the case of no U.S. defenses.

Of more significance is the change in the area of U.S. conditional survival. The number of U.S. killer RVs has been increased by 700 (1000 MX killers minus 300 retired Minuteman killers), thus raising the curve of U.S. conditional survival on the vertical axis from the base case level. The point on the x-axis moves to the left to reflect the fact that, with the U.S. addition of 700 accurate RVs, fewer Soviet ICBM RVs would survive a U.S. first strike.

The number of surviving Soviet ICBM RVs in the absence of any Soviet defense has been reduced to around 1100. This figure, added to the 1000 Soviet nontargetable SLBM RVs at sea, makes a total of 2100 Soviet RVs likely to survive a U.S. attack in the absence of any Soviet strategic defense.

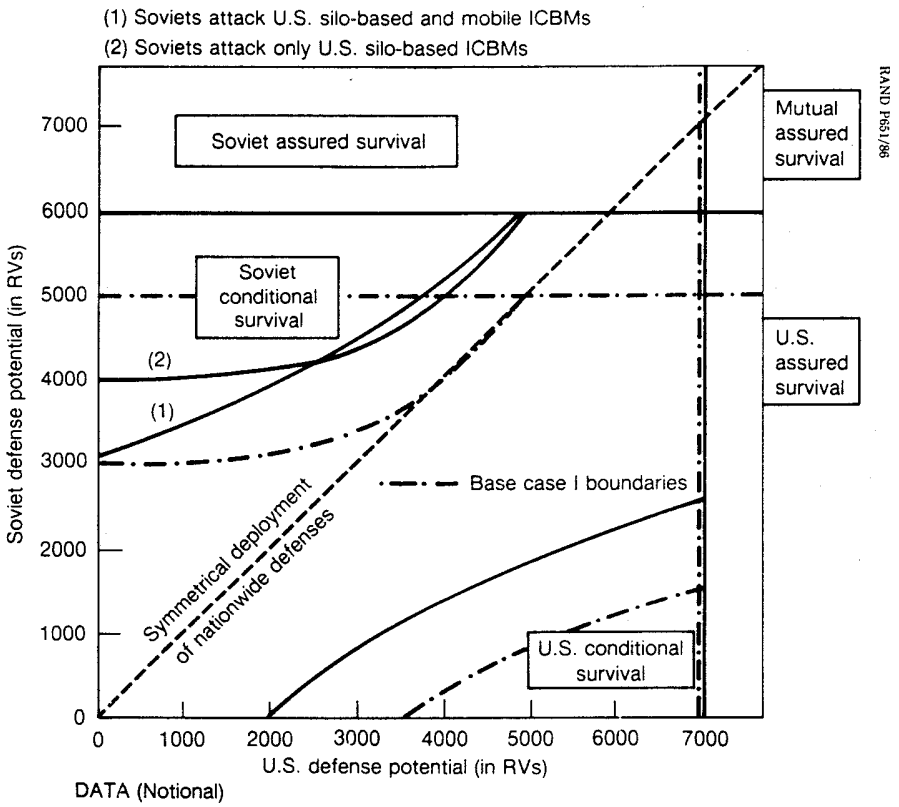
The Soviet conditional survival line retreated slightly by virtue of more U.S. RVs on station. The U.S. conditional survival line advanced considerably. As a result, the transition zone is still open but has been narrowed. An increase in the number of killers by one country without a compensating increase in aim points by the other obviously narrows the transition zones. The converse also holds true: An increase in aim points by one country without a compensating increase in the other's number of killer RVs will widen the transition avenue.

U.S. Deployment of Small ICBMs on Hardened Mobile Launchers

The posture of U.S. offensive forces changes in Fig. 7 with the addition of 1000 U.S. ICBM RVs on hardened mobile launchers, deployed randomly over a 10,000-square-nautical-mile area. This deployment calls for a new description of Soviet killers.

Soviet killers are assigned a probability of kill for point targets. For area targets, we must also assign them a bombardment area. In this case, the bombardment area of the nominal Soviet RV against the hardened transporter is taken as 4 square nautical miles.[10] If the U.S.

[10]The bombardment area for a single RV is derived by taking the nominal yield of Soviet RVs to be used for this purpose, observing the radius of effect of these RVs against the transporter with a given hardness, and then calculating the bombardment area according to the formula πr^2, where r is the radius of effect. The bombardment area might be as small as 2 nm^2 if the mobile launcher were assumed to be as hard as 50 psi and no allowance were made for upgrading the yield of Soviet RVs of a given weight.



DATA (Notional)

- Nationwide defenses operate in discriminating random subtractive mode and are invulnerable to suppression
- U.S. Force: 6000 on-station RVs, including
  - 3000 ICBM RVs, of which 2500 RVs are killers, 1500 with 0.4 P_k and 1000 with 0.7 P_k against Soviet silos; the 3000 include
    - 2000 RVs in 1000 silos
    - 1000 RVs on transporters deployed randomly over 10,000 nm^2
  - 3000 nontargetable RVs
- Soviet Force: 7000 on-station RVs, including
  - 6000 ICBM RVs in 1400 silos, of which 5000 RVs are killers with 0.7 P_k against U.S. silos
  - 1000 nontargetable RVs

Fig. 7—Effect on base case I operational capabilities of 1000 RVs deployed on hardened mobile launchers

deployment area of the mobile missile is 10,000 square miles, then the United States, through this new deployment, has added the equivalent of 2500 additional aim points. Not surprisingly, this increase in U.S. aim points significantly affects the area of Soviet conditional survival.

First, examine the effect of the U.S. addition of 1000 RVs on the area of U.S. conditional survival. These RVs are assumed to have an accurate guidance system and thus an effective P_k against Soviet silos. Consequently, the effect on the U.S. conditional survival area of 1000 RVs on mobile launchers is quite similar to the addition of 1000 RVs on 100 MX missiles in Fig. 6, above. The slight increase in Fig. 7 stems from the fact that no U.S. killer ICBM RVs were retired to make way for the 1000 RVs on mobile launchers.

The increase in the total number of U.S. RVs on station would raise the horizontal line representing Soviet assured survival from U.S. ballistic missile attack from 5000 RVs in the base case (dot-dashed line) to 6000 RVs. This is essentially the same effect as the addition of MXs in Fig. 6, above.

The increase in U.S. aim points reduces the curve (1) of Soviet conditional survival as compared with the base case curve. Should the Soviets strike first, they would have to target a U.S. ICBM force consisting in Fig. 7 of 3000 RVs deployed in 3500 aim points (1000 Minuteman silos plus 2500 aim points for the 10,000 square miles of deployment area of the mobile launchers), as opposed to the 1000 aim points of the base case curve.[11]

The Soviets might, in contrast, attack only the Minuteman silos and, in effect, place the mobile missiles in sanctuary. Line (2) delineates the area of Soviet conditional survival if the Soviets were to make such a decision. In the absence of any U.S. strategic nationwide defense, roughly 4000 U.S. RVs would survive a Soviet first strike (3000 nontargetable SLBM RVs plus the 1000 RVs deployed randomly on mobile hardened launchers, which the Soviets chose not to attack). The Soviets would attack the 1000 Minuteman silos, and the bow would reappear in the curve, owing to the large ratio of Soviet attackers (5000) to U.S. aim points (now back to 1000).

When U.S. defenses could intercept roughly 3000 RVs or more, line (2) would be lower than line (1). This means that the optimal Soviet strategy would be to place the mobile RVs in sanctuary when U.S. nationwide defense potential exceeded a certain level and to attack

[11]The Soviets would allocate their attack between Minuteman silos and the deployment area of the mobile missiles to maximize the number of U.S. ICBM RVs killed. For the ICBM deployments described above and no U.S. defenses, the optimal Soviet attack strategy would be an even split—2500 RVs on Minuteman silos and 2500 on the deployment area.

only the ICBM RVs deployed at fixed sites. The crossover point would depend, of course, on the deployment area of the RVs on mobile hardened launchers and the number of RVs in that area.

Figure 7 again demonstrates that the addition of U.S. killer RVs expands the U.S. area of conditional survival. Moreover, the addition of aim points by the United States causes the Soviet area of conditional survival to retreat from the 45 degree line of symmetrical defense deployments. As a net result of these two changes, the width of the transition zone would be about the same as that of the base case, as shown by the dot-dashed line.

However, the transition zone would shift much closer to the center of the graph. This means that the United States could avoid the area of Soviet conditional survival in a transition without being compelled to outbuild the Soviets in defense potential by a 2-to-1 margin.

U.S. Deployment of Local Defenses of ICBMs

In Fig. 8, U.S. strategic nationwide defenses operating in a discriminating subtractive mode are supplemented by local defenses of fixed-site U.S. ICBMs. These local defenses are assumed to operate in a semipreferential mode. In this instance, semipreferential, as opposed to complete preferential, means that the ground-based terminal interceptors are allocated to defend certain silos prior to the attack and that the defender does not have the capability to alter this allocation once the attack begins.[12]

As neither side has deployed any additional RVs over the base case, the areas of U.S. and Soviet assured survival are identical to those in Figures 1 and 4. Moreover, the U.S. conditional survival area is also identical to that of the base case, because the U.S. total of killer RVs has not changed and the Soviets have altered neither the total number of RVs on station nor their deployment posture.

The U.S. deployment of local defenses would affect the shape of the Soviet conditional survival area. A Soviet attack on U.S. ICBMs would now have to penetrate both U.S. nationwide and local defenses. As a result, more U.S. ICBM RVs would survive an attack at a given level of U.S. nationwide defense potential and could therefore be used to retaliate. To attain conditional survival in the face of this increased U.S. retaliatory capability, the Soviets would have to deploy more nationwide defense potential than previously.

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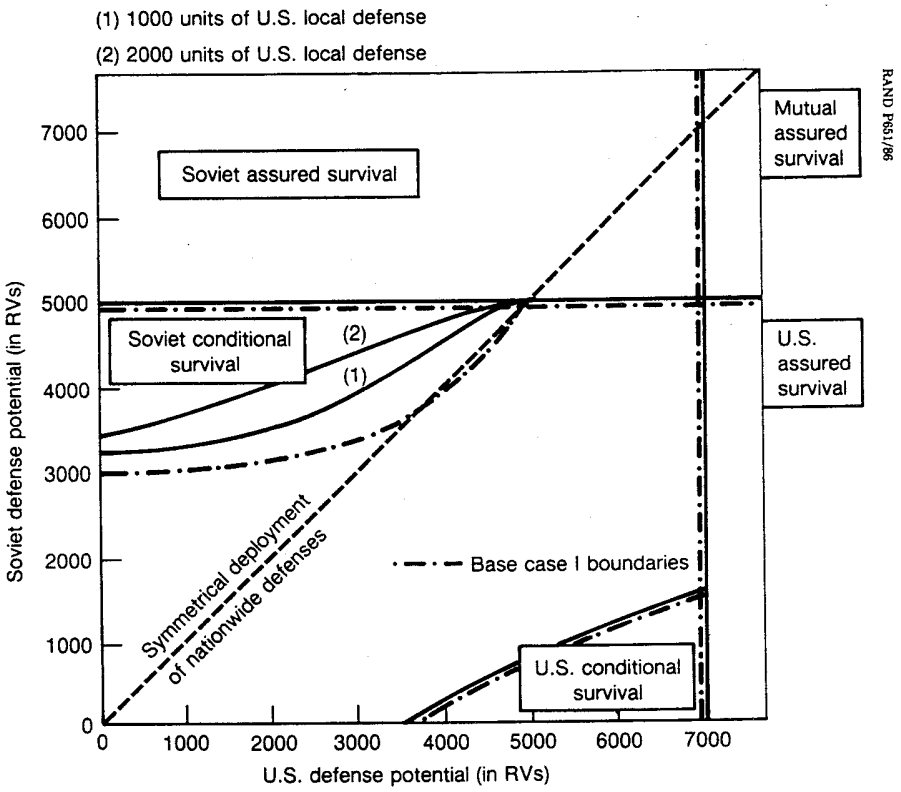
[12]See the Appendix for further discussion of the various defense operating modes and the formulas for calculating the percentage of forces surviving a given attack and a given level and type of defense.



DATA (Notional)

- Nationwide defenses operate in discriminating random subtractive mode; local defenses, in discriminating semipreferential mode; both are invulnerable to suppression
- U.S. Force: 5000 on-station RVs, including
  - 2000 ICBM RVs in 1000 silos, of which 1500 RVs are killers with 0.4 P_k against Soviet silos
  - 3000 nontargetable RVs
- Soviet Force: 7000 on-station RVs, including
  - 6000 ICBM RVs in 1400 silos, of which 5000 RVs are killers with 0.7 P_k against U.S. silos
  - 1000 nontargetable RVs

Fig. 8—Effect on base case I operational capabilities of U.S. local defenses of ICBMs

Thus, the U.S. deployment of local defenses operating in the semipreferential mode would force the Soviet conditional survival curve to retreat slightly upward from the baseline case of Fig. 5. Figure 8 displays the Soviet conditional survival curve for the U.S. deployment of 1000 perfect interceptors to defend the 1000 Minuteman silos (curve 1) or 2000 perfect interceptors (curve 2).

According to Fig. 8, U.S. local defenses would have their greatest impact on Soviet conditional survival after the United States had already deployed modest levels (2000 to 4000 units) of nationwide defense potential. Said somewhat differently, U.S. local defenses would have only a marginal effect on Soviet conditional survival at very low or very high levels of U.S. strategic nationwide defense potential.

In the absence of any U.S. nationwide defense, 1000 to 2000 U.S. local interceptors operating in a discriminating semipreferential mode would have little effect on the survival of U.S. ICBM RVs in the face of the massive Soviet counterforce capability. Moreover, the small number of ICBM RVs that would survive if the United States were to deploy 1000 to 2000 units of local defenses would increase present-day U.S. ballistic missile retaliatory capability (3000 nontargetables) only by some 10 percent to 15 percent.

At the opposite extreme, with high levels of U.S. nationwide defense potential, most if not all U.S. ICBM RVs would already survive. Thus, the addition of local defenses again would have a marginal effect.

Local defenses would have the greatest impact midway through the transition from no nationwide defense to levels of nationwide defense high enough to provide an assured survival capability. Only after the United States had deployed enough nationwide defense to begin thinning out the Soviet attack could local defense make a sizable difference in terms of the number of surviving U.S. ICBM RVs.

In summary, the addition of U.S. local defenses would push the Soviet conditional survival area upward, with the greatest retreat in the middle after modest levels of U.S. nationwide defense potential had been deployed and least retreat at the points for zero and 5000 units of U.S. nationwide defense potential. The policy implication is that local defenses might be deployed to aid a safe transition, but that such defenses would not be a significant factor in the absence of nationwide defenses. Accordingly, we believe that amending the ABM treaty to permit local defenses of ICBMs would serve no useful purpose for the United States when, as is currently the case, the defense lacks leverage.

U.S. Deployment of Small ICBMs and Local ICBM Defense

In Fig. 9, we alter the base case U.S. offensive force posture by combining elements from the two preceding figures: the 1000 RVs on hardened mobile launchers of Fig. 7 and the 1000 perfect interceptors (deployed around Minuteman silos) of Fig. 8.

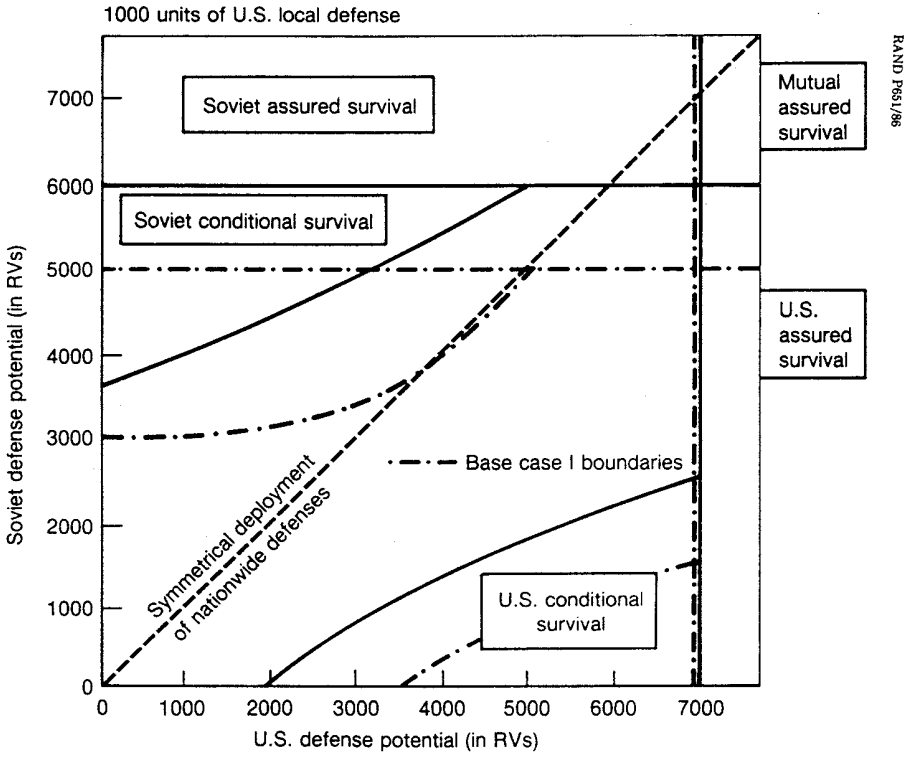
The area of U.S. conditional survival would increase just as it did in Fig. 8, because the 1000 additional U.S. ICBM RVs on mobile launchers were killers. The United States would now be able to effectively target a greater portion of the Soviet ICBM force in a hypothetical first strike. For example, if the Soviet defense potential equaled zero, about 1000 of the 6000 Soviet ICBM RVs could be expected to survive a U.S. first strike. (As noted earlier, at least 2500 Soviet ICBM RVs would survive a first strike by a U.S. ICBM force that did not include the 1000 killer RVs on hardened mobile launchers.)

The enhanced U.S. attack capability would reduce Soviet ballistic missile retaliatory capability for a given level of Soviet nationwide missile defense. Decreased Soviet retaliatory capability would, in turn, lower the level of defense required by the United States to obtain a capability of conditional survival from Soviet ballistic missile attack. The U.S. strategic defense requirement to obtain an assured survival capability would not change, because the Soviets deployed no additional RVs.

The impact of the U.S. offensive and defensive force alterations listed above on Soviet conditional and assured survival capabilities would be quite similar to that shown in Figs. 7 and 8. First, the 1000 additional RVs in the U.S. arsenal would raise by a matching amount the level of Soviet defense potential required to provide the Soviets with an assured survival capability from a U.S. ballistic missile attack.

Furthermore, the combination of additional U.S. aim points and local defense of existing U.S. ICBM silos would force the Soviet conditional survival curve upward. If the Soviets targeted the entire U.S. ICBM force (mobile and fixed-site missiles), they would pay a higher price to attack the 1000 existing Minuteman silos; they would also have to spread their attack over an additional 2500 aim points. Given these changes, more U.S. ICBM RVs at each level of U.S. nationwide defense potential would survive the diluted Soviet first strike and could be used to retaliate.

These unilateral U.S. survivability measures would have a twofold effect on the transition to U.S. (and perhaps Soviet) assured survival. First, the avenue for a safe, stable transition would have widened somewhat with the addition of U.S. aim points and terminal



DATA (Notional)

- Nationwide defenses operate in discriminating random subtractive mode; local defenses, in discriminating semipreferential mode; both are invulnerable to suppression
- U.S. Force: 6000 on-station RVs, including
  - 3000 ICBM RVs, of which 2500 are killers, 1500 with 0.4 P_k and 1000 with 0.7 P_k against Soviet silos; the 3000 RVs include
    - 2000 RVs in 1000 silos
    - 1000 RVs on transporters deployed randomly over 10,000 nm^2
  - 3000 nontargetable RVs
- Soviet Force: 7000 on-station RVs, including
  - 6000 ICBM RVs in 1400 silos, of which 5000 RVs are killers with 0.7 P_k against U.S. silos and 4 nm^2 bombardment area against mobile launchers
  - 1000 nontargetable RVs

Fig. 9—Effect on base case I operational capabilities of 1000 RVs deployed on hardened mobile launchers and local defenses of ICBMs

interceptors. Second, this path would have moved much closer to the 45 degree line that denotes symmetrical deployments of nationwide defense potential. Said somewhat differently, U.S. deployment of nationwide defense potential would no longer need to outpace Soviet potential by 2 to 1 (i.e., two U.S. units of strategic nationwide defense potential to one unit of Soviet defense potential) to ensure a smooth transition to U.S. (and perhaps Soviet) assured survival; even a worst-case scenario would require at most a ratio of 1.5 to 1.

Effective Defense-Suppression Forces

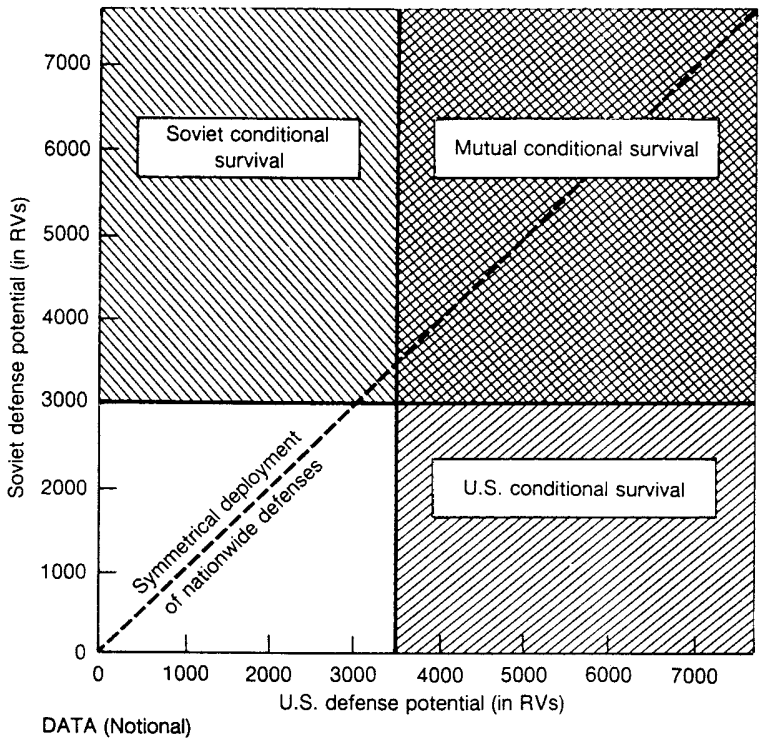
Figure 10 illustrates the outcome if U.S. and Soviet defense-suppression forces were completely effective in disabling the opponent's strategic defenses in a first strike. The analysis in this case assumes that the attacker could disable not only the enemy's vulnerable defenses, but also his defense-suppression forces, thereby ensuring that the attacker's defenses survive.

The first observation one can make about the outcome is that the areas representing U.S. and Soviet assured survival capability are missing. Obviously, neither side could be assured that it was capable of surviving an enemy's ballistic missile first strike if it depended solely on vulnerable defenses to provide it with such a capability. In other words, if a country's nationwide defenses could not survive an enemy first strike, the country itself could not be assured of surviving the attack.

The second observation about Fig. 10 is that the entry points for U.S. and Soviet conditional survival on the x- and y-axes, respectively, are identical to what they were in our base case illustrated in Fig. 4, above: roughly a defense potential of 3000 in both cases. These points were derived just as they were for cases involving invulnerable nationwide defenses, as discussed above.

The assumptions implicit in this analysis also lead to a third observation concerning the size and shape of the areas of U.S. and Soviet conditional survival. Given our assumption in Fig. 10 that the attacker could completely disable any level of enemy strategic nationwide defenses in a first strike, the effectiveness of the attacker's strike on the enemy's strategic offensive forces would be exactly the same regardless of the initial enemy defense level.

The ability to completely disable the enemy's vulnerable defenses would allow the attacker to carry out his offensive counterforce attack unimpeded. Thus, the potential attacker's calculation of how much nationwide ballistic missile defense he needed to survive a ragged retaliatory attack and attain conditional survival would be totally



DATA (Notional)

- Nationwide defenses operate in discriminating random subtractive mode; defenses and defense-suppression forces are vulnerable to suppression
- U.S. Force: 5000 on-station RVs, including
  - 2000 ICBM RVs in 1000 silos, of which 1500 RVs are killers with 0.4 P_k against Soviet silos
  - 3000 nontargetable RVs
- Soviet Force: 7000 on-station RVs, including
  - 6000 ICBM RVs in 1400 silos, of which 5000 RVs are killers with 0.7 P_k against U.S. silos
  - 1000 nontargetable RVs

Fig. 10—Operational capabilities if both U.S. and USSR deploy highly effective strategic defense-suppression forces

independent of the size of the enemy's deployment of vulnerable nationwide defenses.

The areas of U.S. and Soviet conditional survival are greatly expanded in Fig. 10, and they would no longer retreat as the other deployed higher levels of strategic nationwide defense potential. The result is a large area of joint U.S. and Soviet conditional survival. In this intersection, labeled Mutual Conditional Survival, each side could ensure its own survival from the other's ballistic missile attack only by striking the first blow and neither could survive if it allowed the other to attack first. Obviously, this would lead to an extremely unstable world.

Fig. 10 graphically emphasizes the obvious. Strategic ballistic missile defenses must be invulnerable to enemy attack. However, given the likely nature of future U.S. and Soviet defenses, it is difficult to conceive that all components of these deployments will prove totally invulnerable. Unilateral Soviet acquisition of the capability to suppress U.S. defenses could place the United States at a strategic disadvantage.

As a second requirement of the transition to assured survival from ballistic missile attack, therefore, the United States should strive to develop and deploy its own survivable and effective defense-suppression forces. If the United States had such forces, a Soviet planner would be less tempted to strike first because he would know that his defenses could be disabled and could therefore offer little protection from a U.S. retaliatory attack.[13]

U.S. and Soviet Force Modernization

In Fig. 11, we again assume that U.S. and Soviet strategic nationwide defenses are invulnerable to defense-suppression efforts. We assume also that both the United States and the Soviet Union have modernized their strategic offensive forces, while adhering for the most part to the constraints of the 1979 SALT II treaty. As a result, several major changes have been made in the base case of current U.S. and Soviet ballistic missile forces. The first change is in the total number of on-station ICBM and SLBM weapons deployed by each side.

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[13]In another scenario, the defense-suppression forces of the country under attack might not be vulnerable and therefore could disable the attacker's strategic defenses. In this situation, both countries would be left without defenses. The end result of such a scenario is the same as if neither country had deployed defenses. Like the situation today, each side would lack an assured survival capability but would have a credible deterrent.

In the new scenario, we assume that the Soviet total of on-station RVs has risen from 7000 to nearly 10,000 and the U.S. total from 5000 to 6200 RVs. Moreover, this increase in on-station RVs is based entirely on larger U.S. and Soviet ICBM forces; the number of SLBM RVs (nontargetables) on station in this case did not change for the United States and only slightly increased for the Soviet Union.

Also, both sides have added substantially to their inventories of hard-target kill-capable RVs. The United States now has 3200 killers on ICBMs and nearly 1500 on SLBMs. The Soviets have 8200 ICBM RVs capable of effectively attacking hardened U.S. targets.

The superpower inventories have been expanded in Fig. 11 without a corresponding increase in either side's number of aim points. In other words, each side has chosen to deploy many more weapons than it has today, in an equal number (in the U.S. case) or a smaller number (in the Soviet case) of aim points.

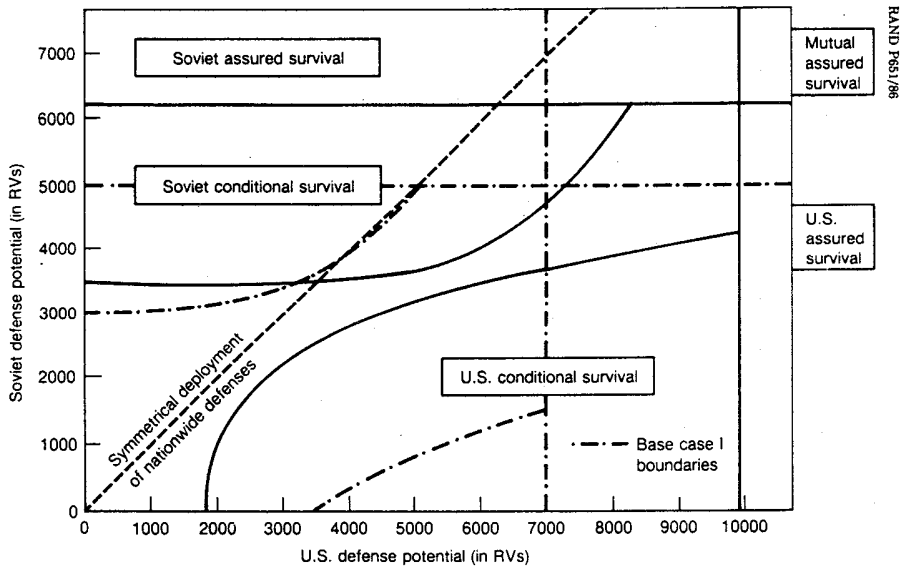
The increase in the number of Soviet ballistic missile RVs on station would increase the level of strategic nationwide defense that the United States would require to attain an assured survival capability from a Soviet ballistic missile attack. This requirement would shift the line for U.S. assured survival to the right on the x-axis in Fig. 11. Similarly, the line for Soviet assured survival would shift up the y-axis.

The Soviet conditional survival area looks much as it did in the base case illustrated in Fig. 4, above. The ratio of Soviet attackers to U.S. aim points would continue to heavily favor the Soviets. The tremendous Soviet overkill would still require the United States to deploy ballistic missile defenses with a great deal of defense potential before U.S. ICBM retaliatory capability would demonstrably increase.

The size of the U.S. conditional survival area would have grown substantially over what it had been in any previous case involving invulnerable defenses operating in a discriminating random subtractive mode. The combination of more Soviet RVs in fewer aim points, no increase in nontargetable Soviet RVs, and a greater number of U.S. killers brought about the enlargement of the U.S. conditional survival area.

In Fig. 11, one no longer sees a wide open avenue for transition to mutual assured survival—even with the assumption that the defenses are invulnerable. In other words, the deployment of effective and invulnerable defenses is no guarantee that a safe transition to assured survival is possible.

Both superpowers must prudently plan the posture of their strategic offensive forces to rule out the situation illustrated in Fig. 11. Arms control that limits the number of ballistic missile RVs and the amount of throwweight and does not prohibit unilateral force survivability



DATA (Notional)

- Nationwide defenses operate in discriminating random subtractive mode and are invulnerable to suppression
- U.S. Force: 6200 on-station RVs, including 4200 killers
  - 3200 ICBM RVs, of which 1500 are killers with 0.7 P_k and 1200 with 0.4 P_k against Soviet silos
    - 2700 RVs in 1000 silos
    - 500 RVs on transporters randomly deployed over 10,000 nm^2
  - 3000 nontargetable RVs, of which 1500 are killers with 0.7 P_k against Soviet silos
- Soviet Force: 9900 on-station RVs
  - 8800 ICBM RVs, of which 8200 are killers with 0.7 P_k against U.S. silos
    - 8200 RVs in 820 silos
    - 600 RVs on transporters deployed randomly over 20,000 nm^2
    - 1100 nontargetable RVs

Fig. 11—U.S. and Soviet operational capabilities if both modernize their ballistic missile forces

measures can prevent these overlaps and thus facilitate the transition. To ensure a safe transition to assured survival, each side should deploy large numbers of nontargetable RVs and the number of the potential attacker's killer RVs must not greatly exceed the number of aim points in which the defender's targetable forces are based.

GRADIENTS OF BALLISTIC MISSILE RETALIATORY CAPABILITY

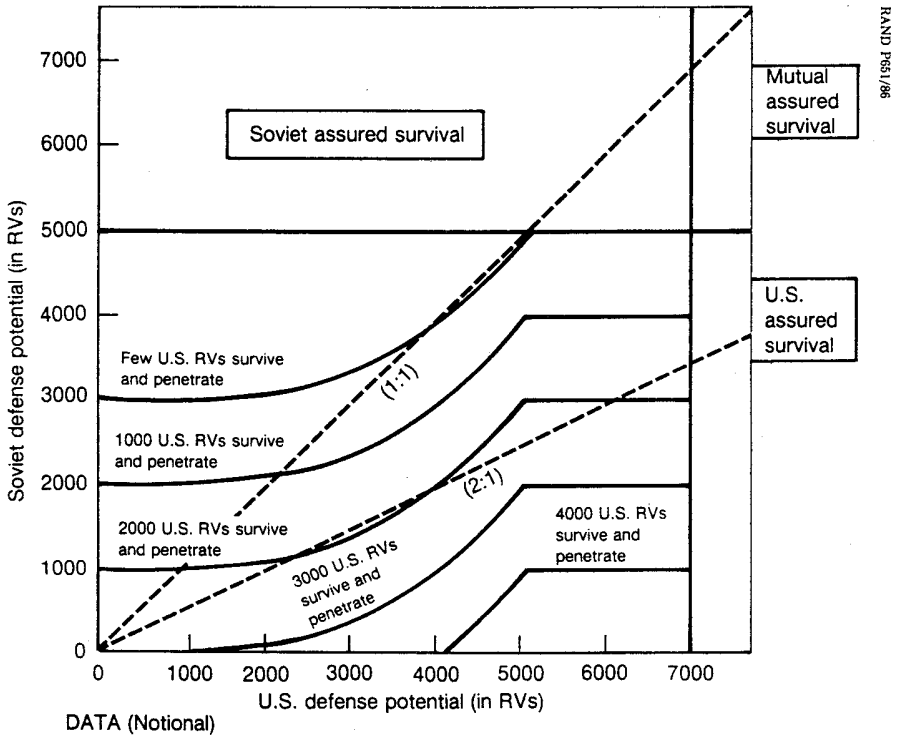
In the absence of nationwide ballistic missile defenses (the 0–0 position on the above figures) each superpower presently has a ballistic missile retaliatory capability of approximately 3000 RVs; i.e., 3000 U.S. or 3500 Soviet RVs would survive the other's first strike and could be expected to reach the attacker's homeland if launched in retaliation. The U.S. total consists solely of the 3000 nontargetable RVs at sea; all 2000 or so U.S. ICBM RVs would likely be destroyed. Because the U.S. currently lacks the capability to destroy all Soviet ICBMs, the Soviet retaliatory capability consists of some 2500 targetable ICBM RVs and about 1000 nontargetable SLBM RVs.

Moving up the 45 degree line of symmetrical deployments of nationwide defenses in the base case (see Fig. 4, above), we reach the area of Soviet conditional survival. At this point the Soviets, through a combination of strategic offensive and defensive deployments, would have attained the capability to strike first, and if the leak rate of their strategic defense was low, they would survive the ragged U.S. retaliatory response, at least as far as U.S. ballistic missiles were concerned. By our definition of Soviet conditional survival, U.S. ballistic missile retaliatory capability would have been reduced to (near) zero.

A series of gradient lines can be drawn to trace the decrease in U.S. ballistic missile capability from 3000 RVs likely to survive a Soviet attack and penetrate to the Soviet homeland at the 0–0 position of superpower strategic defenses to few U.S. RVs midway up the 45 degree diagonal. These same gradient lines can also be drawn to illustrate what happens to Soviet ballistic missile retaliatory capability with the deployment of nationwide defenses. The next several figures will trace the gradients for U.S. and Soviet ballistic missile retaliatory capability for both present-day offensive force postures and for the enhanced U.S. posture described in Fig. 9, above.

U.S. Ballistic Missile Retaliatory Gradients: Base Case

Figure 12 illustrates gradients for U.S. ballistic missile retaliatory capability, given present-day U.S. and Soviet strategic ballistic missile forces (the base case described in Fig. 4, above). In Fig. 12, the area of Soviet conditional survival is now labeled "Few U.S. ballistic missile weapons survive and penetrate." For combinations of U.S. and Soviet defense potential within this area, the Soviets can strike first with



DATA (Notional)

- Nationwide defenses operate in discriminating random subtractive mode and are invulnerable to suppression
- U.S. Force: 5000 on-station RVs, including
  - 2000 ICBM RVs in 1000 silos, of which 1500 RVs are killers with 0.4 P_k against Soviet silos
  - 3000 nontargetable RVs
- Soviet Force: 7000 on-station RVs, including
  - 6000 ICBM RVs in 1400 silos, of which 5000 RVs are killers with 0.7 P_k against U.S. silos
  - 1000 nontargetable RVs

Fig. 12—U.S. ballistic missile retaliatory gradients for base case I

their strategic ballistic missile forces and use their defenses to reduce the number of U.S. ballistic missile weapons that impact on Soviet territory to nearly zero.

If Soviet defense potential were everywhere reduced by 1000 for a given level of U.S. defense potential, 1000 U.S. ballistic missile weapons would be able to penetrate the less robust Soviet defenses. We repeated the reduction process several times to show the remaining gradients.

As noted, the gradient signifying a U.S. ballistic missile retaliatory capability of 3000 RVs passes through the origin (no U.S. or Soviet nationwide defenses). If the United States and the Soviet Union were to deploy nationwide defense potential symmetrically (the line marked "1:1"), with existing strategic offensive forces, U.S. ballistic missile retaliatory capability would decrease steadily and continuously from 3000 RVs to few RVs.

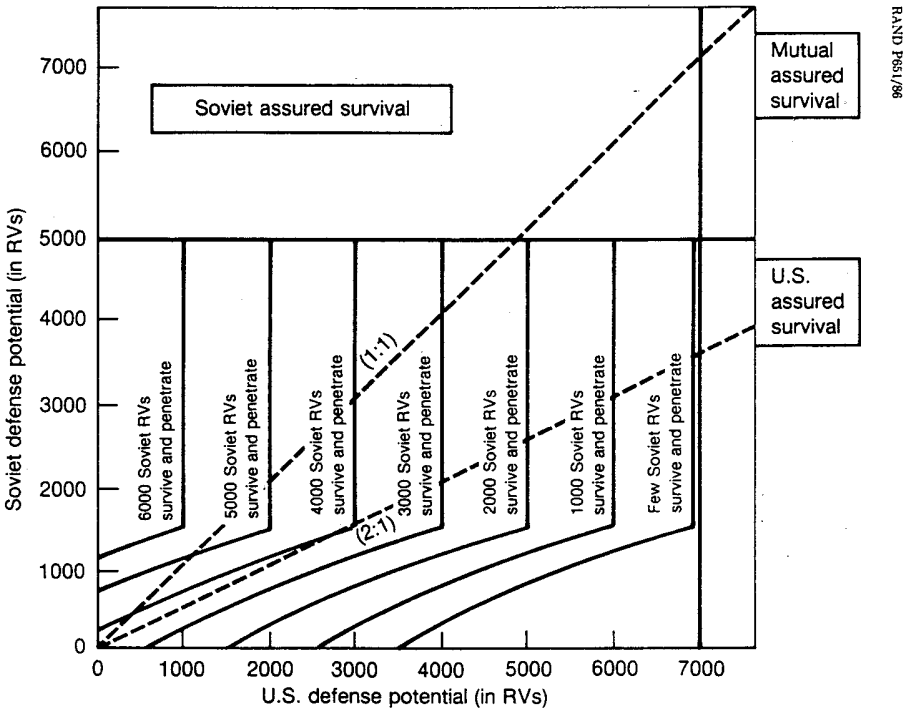
To maintain a comfortable margin in terms of ballistic missile retaliatory capability, given existing deployments of strategic ballistic missile forces, the United States would have to deploy nationwide defense potential at approximately twice the rate of the Soviet Union. This is demonstrated by following the line marked "2:1," i.e., two units of U.S. defense potential for every unit of Soviet defense potential.

If the U.S. rate of defense potential deployment outpaced the Soviet by a 2-to-1 margin, the United States would eventually attain an assured survival capability without U.S. ballistic missile retaliatory capability ever having fallen below 1500 RVs. In other words, the United States would be able to make the transition to assured survival while still retaining a ballistic missile retaliatory margin of 1500 RVs.

Soviet Ballistic Missile Retaliatory Gradients: Base Case

The gradients for Soviet ballistic missile retaliatory capability, given current U.S. and Soviet strategic ballistic missile forces, are illustrated in Fig. 13. Here, the U.S. conditional survival area of the base case is marked "Few Soviet weapons survive and penetrate." The other gradients in Fig. 13 are traced as in Fig. 12, above.

The major difference between the superpower gradients is that along the line for symmetrical deployments of nationwide defense potential (1 to 1), Soviet ballistic missile retaliatory capability would increase initially, whereas as shown in Fig. 12, above, the U.S. retaliatory capability would always decrease.



DATA (Notional)

- Nationwide defenses operate in discriminating random subtractive mode and are invulnerable to suppression
- U.S. Force: 5000 on-station RVs, including
  - 2000 ICBM RVs in 1000 silos, of which 1500 RVs are killers with 0.4 P_k against Soviet silos
  - 3000 nontargetable RVs
- Soviet Force: 7000 on-station RVs, including
  - 6000 ICBM RVs in 1400 silos, of which 5000 RVs are killers with 0.7 P_k against U.S. silos
  - 1000 nontargetable RVs

Fig. 13—Soviet ballistic missile retaliatory gradients for base case I

As seen from Fig. 13, Soviet ballistic missile retaliatory capability would increase from roughly 3500 RVs at the 0–0 level of defense to roughly 5500 RVs when both sides had a defense potential of 1500. This is consistent with the information in Fig. 3. At a defense potential of 1500, the Soviets could stop nearly all U.S. killers with their defenses, so that all 6000 Soviet ICBM RVs and 1000 nontargetable RVs would survive. These 7000 surviving Soviet RVs would then have to fly through U.S. nationwide defenses of equal capability (1500 defense potential) and about 5500 could be expected to reach their targets in the United States.

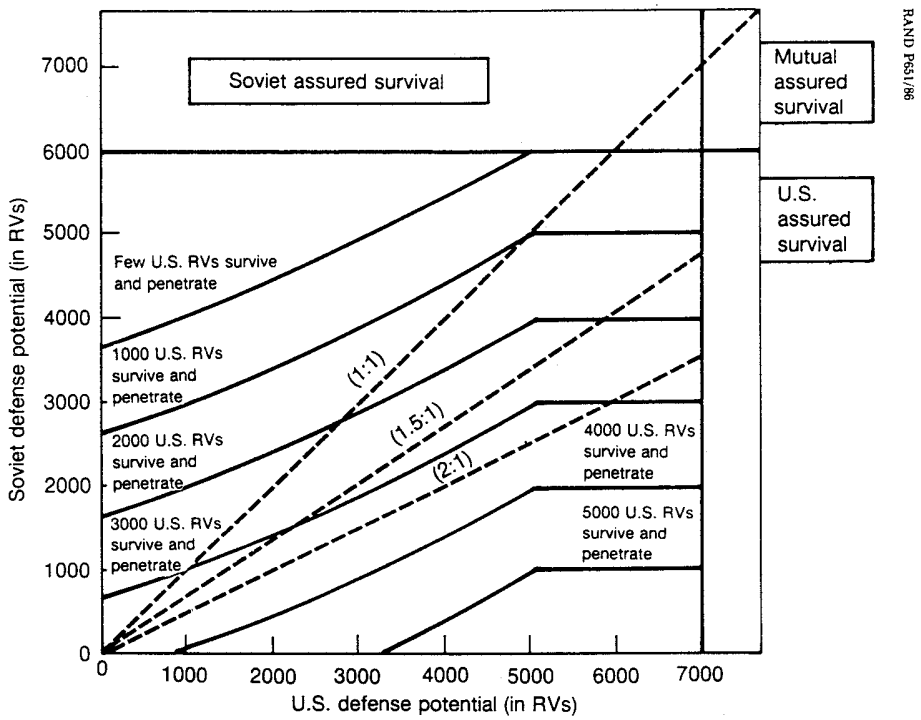
Soviet ballistic missile retaliatory capability would begin to decrease as U.S. and Soviet defense potential exceeded 1500, because the additional Soviet defenses would not generate any more surviving RVs while the U.S. defenses reduce the number that penetrated.

Superimposing U.S. ballistic missile retaliatory gradient on the Soviet gradient, one would see that, although the regions of no U.S. and Soviet ballistic missile retaliatory capability do not overlap, U.S. and Soviet lines for 2000 RVs of retaliatory capability intersect, at least in the early stages of the transition. This means that if the United States and the Soviet Union were to undertake the transition with the present posture of offensive forces, one superpower would have to prepare to go below a margin of 2000 RVs for at least a portion of the transition.

In summary, the asymmetry in superpower ballistic missile forces would significantly affect U.S. and Soviet ballistic missile retaliatory capability if the transition to assured survival were undertaken. Along the line for symmetrical deployments of defense potential, U.S. ballistic missile retaliatory capability would always decrease, while Soviet ballistic missile retaliatory capability would increase up to the 1500 level of defense potential before declining. To preclude this development and maintain a meaningful ballistic missile retaliatory capability, given existing offensive forces, the United States would have to deploy nationwide defense potential at a rate nearly twice that of the Soviet Union.

U.S. and Soviet Ballistic Missile Retaliatory Gradients: U.S. Deployment of Small ICBMs and Local ICBM Defenses

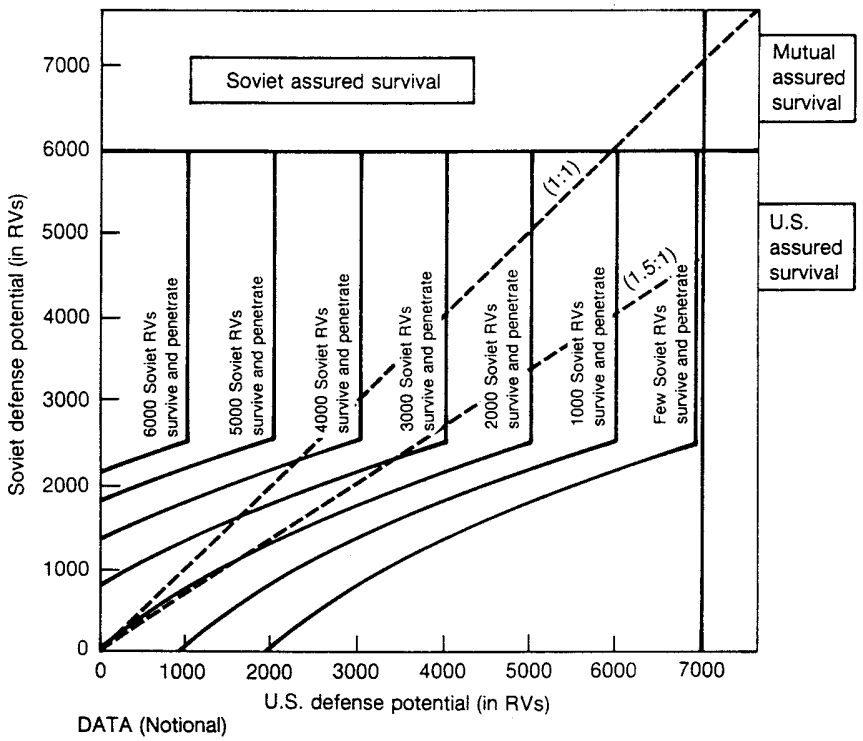
In Figs. 14 and 15, we vary the posture of U.S. forces to assess how these changes would affect U.S. and Soviet ballistic missile retaliatory capability for various rates of defense deployment. The U.S. force posture is identical to that used in Fig. 9, above. We added 1000 ICBM



DATA (Notional)

- Nationwide defenses operate in discriminating random subtractive mode; local defenses, in discriminating semipreferential mode; both are invulnerable to suppression
- U.S. Force: 6000 on-station RVs, including
  - 3000 ICBM RVs, of which 2500 are killers, 1500 with 0.4 P_k and 1000 with 0.7 P_k against Soviet silos; the 3000 RVs include
    - 2000 RVs in 1000 silos
    - 1000 RVs on transporters deployed randomly over 10,000 nm^2
  - 3000 nontargetable RVs
- Soviet Force: 7000 on-station RVs, including
  - 6000 ICBM RVs in 1400 silos, of which 5000 RVs are killers with 0.7 P_k against U.S. silos and 4 nm^2 bombardment area against mobile launchers
  - 1000 nontargetable RVs

Fig. 14—U.S. ballistic missile retaliatory gradients if U.S. deploys 1000 RVs on hardened mobile launchers and local defenses of ICBMs



DATA (Notional)

- Nationwide defenses operate in discriminating random subtractive mode; local defenses, in discriminating semipreferential mode; both are invulnerable to suppression
- U.S. Force: 6000 on-station RVs, including
  - 3000 ICBM RVs, of which 2500 are killers, 1500 with 0.4 P_k and 1000 with 0.7 P_k against Soviet silos; the 3000 RVs include
    - 2000 RVs in 1000 silos
    - 1000 RVs on transporters deployed randomly over 10,000 nm^2
  - 3000 nontargetable RVs
- Soviet Force: 7000 on-station RVs, including
  - 6000 ICBM RVs in 1400 silos, of which 5000 RVs are killers with 0.7 P_k against U.S. silos and 4 nm^2 bombardment area against mobile launchers
  - 1000 nontargetable RVs

Fig. 15—Soviet ballistic missile retaliatory gradients if U.S. deploys 1000 RVs on hardened mobile launchers and local defenses of ICBMs

RVs on mobile hardened launchers deployed over 10,000 square nautical miles and 1000 perfect interceptors for the silo-based RVs. As before, these interceptors operate in a discriminating semipreferential mode.

The addition of these U.S. unilateral force survivability measures would greatly increase the Soviet price to attack U.S. forces. Given a fixed Soviet force posture, the higher cost of attack would mean that more U.S. RVs would survive the Soviet attack. Greater survivability, in turn, would increase the number of U.S. ballistic missile RVs that would penetrate the Soviet Union for a given level of Soviet defense. To attain conditional survival the Soviets would now require more strategic defense than previously and therefore the area of conditional survival would retreat upward and away from the 45 degree diagonal of symmetrical deployment.

If, given these force postures, the United States and the Soviet Union were to deploy strategic nationwide defense potential symmetrically, the U.S. ballistic missile retaliatory capability would still reach nearly zero before the Soviet. However, the United States would no longer need to outbuild the Soviets in defense potential at a 2-to-1 rate to maintain a significant ballistic missile retaliatory capability during the transition to assured survival. The United States would have to deploy nationwide defense potential at a ratio of only 1.5 to 1 to meet the requirement.

Figure 15 displays the gradients of Soviet ballistic missile retaliatory capability, given the above changes in the U.S. force. The addition of U.S. hard-target killers would increase the U.S. capability to target Soviet ICBMs. The United States would be able to kill more Soviet ICBMs for a given level of Soviet defense. In turn, fewer Soviet RVs would penetrate to targets in the United States for a given level of U.S. defense. Consequently, the U.S. conditional survival area (few Soviet ballistic missile weapons survive and penetrate) would expand toward the center of the graph.

Soviet ballistic missile retaliatory capability is about 2000 weapons at the 0–0 point and, like before, would increase if defense potential were deployed symmetrically until Soviet defenses could stop all U.S. killer RVs (Soviet defense potential = 2500), at which point it would begin to steadily decline.

Should the U.S. deployment of nationwide defense potential outpace the Soviet deployment by 1.5 to 1, Soviet ballistic missile retaliatory capability initially would hover between 1000 and 2000 weapons; it would fall below 1000 when the U.S. defense potential exceeded 6000. Naturally, Soviet retaliatory capability would decline faster and further if the U.S. deployment outpaced the Soviet deployment by more than 1.5 to 1.

III. CONCLUDING REMARKS

The transition from the current U.S. posture of no nationwide defense to one in which U.S. defenses are robust enough to ensure the survival of this nation may take many years and will present many difficulties along the way. The defense-potential framework developed in this report enabled us to analyze the problems that might arise during the transition and to suggest measures that each side might take to alleviate potential concerns.

The analysis of current U.S. and Soviet strategic ballistic missile forces and strategic defenses demonstrates that the United States and the Soviet Union could achieve a stable transition and, ultimately, assured survival. If they shared the goal of assured survival, they would seek meaningful constraints on strategic offensive arms, in terms of both the number of weapons and the amount of ballistic missile throwweight. Once they had limited offensive arms in this manner, they could realistically hope to make the transition to mutual assured survival.

If, however, the Soviets decided to retain the capability of their offensive weapons to dominate U.S. defenses, they would deploy many more ballistic missiles with more throwweight and decoys, as well as more bomber weapons, in an effort to overwhelm U.S. defenses. This course of action would lead to instability and an uncertain future.

To ensure a stable transition, the United States would have to (1) produce defenses that were survivable (that is, not readily subject to suppression) and highly effective and (2) deploy up to twice as much defensive capability as the Soviet Union. The latter requirement stems directly from the asymmetries in current U.S. and Soviet strategic ballistic missile forces. By redressing existing imbalances through arms control and/or the modernization of forces and their basing modes, the United States would narrow the margin by which it had to outpace the Soviets.

The deployment by both superpowers of highly survivable strategic offensive forces would greatly facilitate a stable transition. Unilateral measures available to each side to enhance force survivability include the deployment of more weapons at sea, on hardened transporters, or in redundant, very hard silos. In the absence of strategic defenses or redundant shelters to provide leverage, it is judged from this analysis that even robust deployments of local defenses of ICBMs would not significantly increase U.S. ICBM survivability.

To the technical requirements that the United States must meet if it is to make the transition to assured survival must be added a political sine qua non of equal or greater import: the need for public support. Before abandoning the 1972 ABM treaty and deploying strategic defenses, the U.S. government must have a broad consensus and the assurance that the American public will support the huge expenditures that such an effort will require over many years, perhaps approaching two decades.

Finally, once the quest for assured survival begins, the United States must not abandon it while the Soviet Union continues to the end. The failure to complete the transition would seriously compromise U.S. security, whether the transition involved cooperation or competition with the Soviet Union.

Appendix

OPERATING MODES FOR BALLISTIC MISSILE DEFENSES

The capability of strategic nationwide and local ballistic missile defense systems is defined above in terms of their potential to subtract out RVs from an enemy's ballistic missile attack. Depending on the defender's knowledge of the character of the attack and his ability to react to this information, the potential to intercept RVs could be used in several different ways. To describe the precise manner in which a given ballistic missile defense system would subtract out RVs, a second term, defense operating mode, was introduced. This appendix examines in more detail the concept of defense operating mode for both strategic nationwide and local defenses.

Strategic Nationwide Defenses

Strategic nationwide defenses as conceived in this report consist of several layers, the most significant being the space-based battle stations which, when on station, are capable of intercepting any given RV in an enemy attack. The defense might operate in various ways, from randomly subtracting out RVs to attacking only hard-target kill-capable RVs heading toward a specific set of targets, such as an ICBM wing or command and control modes of the defense itself. To explain strategic nationwide defense operating modes, the appendix discusses the following:

- Four basic modes in which, conceptually at least, nationwide ballistic missile defenses might operate
- The level of knowledge as to the character of the attack that a defender would have to possess to operate his defenses in a given mode
- Mathematical formulas to determine and compare the expected effectiveness of the various operating modes in enhancing the survival of a target or set of targets from an attack.[1]

[1]The formulas used to calculate the effectiveness of the various defense operating modes in protecting a target set are defense enforceable. That is, if the defender is operating his defense in a given mode, he can protect at least the fraction of targets indicated by these formulas, and perhaps more, depending on the character of the attack.

Pure Random Subtractive

A nationwide ballistic missile defense capable only of subtracting out RVs from an enemy attack at random, regardless of RV type or intended target, is said to be operating in a pure random subtractive mode. Of the four modes discussed in this appendix, the pure random subtractive mode is the least demanding in terms of battle management and knowledge of the exact character of the attack. To operate a defense optimally in this mode, a defender need not even know the total size of the attack, much less the attacker's allocation of RVs to particular targets.[2]

If a nationwide defense is operated in a pure random subtractive mode, the formula for calculating the expected fraction of defended targets that survive (P_s) is as follows:[3]

$$P_s = \left[1 - \left(\frac{A - D}{A} \cdot P_k\right)\right]^N$$

where A = total number of attacking RVs
D = total defense potential measured in RVs
P_k = probability of kill of killer RV against target
N = total number of killer RVs allocated for a particular target set divided by total number of targets in set.

To assess the effectiveness of defenses operating in the pure random subtractive mode (and, below, in the three other defense operating modes), we calculate the fraction of U.S. and Soviet ICBMs that survive a first strike if we postulate notional U.S. and Soviet strategic ballistic missile forces and vary the amount of U.S. and Soviet nationwide defense potential.

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[2]Although defenses operating in the pure random subtractive mode can only subtract out enemy RVs without regard to where the RV came from or where it is going, we assume that the defenses in this (and all subsequent modes) have sufficient battle management to allow for ordered fire; i.e., the battle stations coordinate their fire so that two stations do not attack the same RV.

[3]The formula presented here applies only when N is an integer. If N is not an integer, P_s can be calculated by using this formula and interpolating, or by using the following more rigorous formula:

$P_s = (1 - fk)(1 - k)^I$
where I = integer part of N
f = fractional part of N
$k = (A - D)/A \cdot P_k$.

The Soviets are assumed to have roughly 7000 RVs on station, 6000 ICBM RVs in 1400 silos and 1000 SLBM RVs. Five thousand of their ICBM RVs are killers; the remaining 2000 Soviet RVs are nonkillers. To simplify the calculation, we postulate that the P_k of a Soviet killer is 1.0 and a nonkiller is 0. The United States is assumed to have 5000 RVs on station, 3000 nontargetable SLBM RVs and 2000 ICBM RVs deployed in 1000 silos. Only 1500 U.S. RVs are killers; they too are postulated to have a 1.0 P_k against Soviet silos.

If one assumed that, as is currently the case, the United States had no nationwide ballistic missile defenses, the formula indicates that few, if any, U.S. ICBM RVs would survive a Soviet first strike.

$$P_s = \left[1 - \left(\frac{7000 - 0}{7000} \cdot 1.0\right)\right]^5$$

$$= \left[1 - 1.0\right]^5$$

$$= \left[0.0\right]^5$$

$$= 0 \ .$$

To ensure that all 2000 U.S. ICBMs survived ($P_s = 1.0$), one can see from the formula that the United States would have to deploy defenses with a potential to subtract out 7000 RVs. (This assumes, of course, these defenses have small inherent leak rates.) The formula also demonstrates that U.S. nationwide defenses would have to intercept nearly 6100 RVs if only half of the 2000 RVs in the U.S. ICBM force were to survive. In other words, given these notional U.S. and Soviet strategic offensive forces, U.S. defenses operating in a random subtractive mode would have to intercept over 6000 Soviet RVs to protect a substantial portion of the 2000 U.S. ICBM RVs.

For the case of a U.S. first strike against Soviet ICBMs, in contrast, nearly half of all Soviet ICBM silos could be expected to survive if the Soviets were to deploy roughly 2500 units of defense potential. To ensure that all 6000 Soviet ICBM RVs survived, the Soviets would have to deploy defenses with a potential to randomly intercept all 5000 U.S. on-station RVs. However, because of the asymmetry in forces, the Soviets would need to only intercept about 3000 RVs to ensure that half of their silos would survive. Unlike the United States, the Soviet Union could save many ICBMs from first-strike attack by intercepting a relatively small number of attacking RVs, even if the defenses could operate only in a random subtractive mode.

Using these same U.S. and Soviet strategic forces, we can calculate the fraction of U.S. and Soviet ICBMs that would survive a first strike by the other for various levels of defense potential operating in a pure random subtractive mode. The results of calculations for this and other U.S. and Soviet defense operating modes appear in Table A.1.

Discriminating Random Subtractive Mode

In the majority of cases in this report, the strategic defenses would operate in the discriminating random subtractive mode. To operate defenses in this mode, a defender would have to be able to discriminate between enemy killer and nonkiller RVs and then preferentially attack only the killers, but without regard to which target they were attacking. The defender again would not need to know the total size of the attack or the allocation of attacking RVs to particular targets to operate the defense optimally.

The following formula would be used to calculate the expected fraction of targets that would survive attack (P_s) if the nationwide defense were operated in a discriminating subtractive mode:

$$P_s = \left[1 - \left(\frac{A_k - D}{A_k} \cdot P_k\right)\right]^N$$

where A_k = total number of attacking killer RVs
D = defense potential measured in RVs
N = total number of killer RVs allocated for target set divided by total number of targets in set
P_k = probability of kill of killer RV against target.

To assess the effectiveness of defenses operating in the discriminating random subtractive mode, we calculate P_s for various amounts of U.S. and Soviet nationwide defense, using the notional U.S. and Soviet strategic offensive forces postulated above.

This formula, like the preceding one, demonstrates that few, if any, U.S. ICBMs would survive a Soviet attack in the absence of any ballistic missile defenses. However, if one assumed that the defenses could preferentially attack killers only, the United States would need to intercept only 5000 RVs (the total number of Soviet killers) to ensure that all U.S. ICBMs survived.

To ensure the survival of at least half of the U.S. ICBM force, the United States would have to deploy defenses with a potential to intercept nearly 4200 of the 5000 Soviet killer RVs. In contrast, the Soviets would need to intercept only the 1500 U.S. killers to ensure the

Table A.1

U.S. AND SOVIET ICBM SURVIVABILITY FOR VARIOUS AMOUNTS AND OPERATING MODES OF STRATEGIC DEFENSE

Defense Potential (in RVs)	Fraction of ICBMs Surviving in Various Operating Modes			
	Pure Random	Discriminating Random	Discriminating Semi-preferential	Discriminating Complete Preferential
	United States			
0	0	0	0	0
1000	0	0	0.11	0.20
2000	0	0.01	0.22	0.40
3000	0.01	0.08	0.33	0.60
4000	0.06	0.33	0.44	0.80
5000	0.19	1.00	0.55	1.00
6000	0.46	1.00	0.62	1.00
7000	1.00	1.00	0.67	1.00
	Soviet Union			
0	0	0	0	0
1000	0.19	0.65	0.56	0.67
2000	0.38	1.00	0.72	1.00
3000	0.58	1.00	0.80	1.00
4000	0.79	1.00	0.84	1.00
5000	1.00	1.00	0.87	1.00
6000	1.00	1.00	0.89	1.00
7000	1.00	1.00	0.90	1.00

DATA (Notional): U.S. Force consists of 5000 on-station RVs, including

— 2000 ICBM RVs in 1000 silos, of which 1500 RVs are killers with 1.0 P_k against Soviet silos

— 3000 nontargetable RVs

Soviet force consists of 7000 on-station RVs, including

— 6000 ICBM RVs in 1400 silos, of which 5000 RVs are killers with 1.0 P_k against U.S. silos

— 1000 nontargetable RVs.

survival of all of their ICBMs from a U.S. ballistic missile attack. Over half the Soviet ICBM force would survive a U.S. attack if the Soviets deployed strategic defense with a potential to preferentially attack about 800 U.S. killer RVs. (The calculations for P_s, given various other levels of discriminating random subtractive defense, appear in Table A.1, above.)

The calculations in Table A.1 suggest that deploying strategic nationwide defenses capable of discriminating killers from nonkillers would help to increase the number of survivors. Despite this evidence that discriminating subtractive defenses would outperform random subtractive, the fact is that neither mode would effectively protect U.S. ICBMs until the United States had deployed fairly robust defenses.

Discriminating Semipreferential Mode

Strategic nationwide defenses could also operate in a discriminating semipreferential mode. Nationwide defenses could operate in a semipreferential mode if the defender in advance allocated his defense potential to defend certain targets within the overall target set. The attacker must not, of course, know the allocation. We assume that he would allocate in advance because he would be unable to detect and react to any anomalies in the enemy attack.

To operate the defense optimally in this mode, the defender would have to know considerably more about the character of the attack than he would in either of the two modes described above. He would have to know the total size of the attack and program his defenses to intercept only the killer RVs headed for the targets that he was preferentially defending. He would therefore have to be able to determine the destination of each enemy RV so as to decide which RVs to attack.

There are two formulas for calculating expected P_s for nationwide defenses operating in a semipreferential mode.[4] If the enemy's offense is dominant, i.e., if less than half of the targets would be expected to survive, then:

$$P_s = \frac{D}{2A_k - T}$$

[4]See R. E. Strauch, *"Shell Game" Aspects of Mobile Terminal ABM Systems*, The Rand Corporation, RM-5474-ARPA, December 1967, for the derivation of these formulas. The formulas apply only when the attacking warheads and defensive interceptors are perfect, i.e., the probability of kill and probability of intercept both equal 1.0.

where A_k = total number of killer RVs allocated for target set
D = defense potential measured in RVs
T = total number of targets.

If the defense is dominant, i.e., if more than half of the targets could be expected to survive, the formula for calculating expected P_s would be as follows:

$$P_s = 1 - \frac{A_k}{2D + T}$$

If exactly half the targets were expected to survive, the two formulas would yield the same result.

The solutions for P_s provided by these formulas are insensitive to variations in the attacker's strategy. The attacker would have the option to tailor his attack; but, if the defense were operated optimally, the attacker could gain no advantage. In other words, the number of targets that survived would not depend on the attacker's specific allocation of attacking RVs to targets. The exceptions to this statement would occur when the attacker engaged in extreme attack strategies, such as 5000 RVs on a single target and none on any other. However, such extreme strategies always provide higher values of P_s.

Moreover, operating defenses in a semipreferential mode, although more difficult than operating in the pure random or discriminating random subtractive modes, would provide the United States better protection of a given target set—at least for low-to-moderate levels of defense potential. At high levels of defense, operating in the semipreferential mode would allow fewer targets to survive than operating in either of the other two modes.

These differences in survival stem from the fact that semipreferential defense would require prior allocation of defense potential. If robust defenses were deployed and operated in a semipreferential mode, some defense potential would inevitably be assigned to defend targets that were attacked lightly, if at all. In this case, because we assumed that the defenses were unable to react to attack anomalies, a certain amount of defense potential would remain just that—potential. Some of the defense would never see or engage any attacking enemy RVs.

Differences in survival would not occur in the case of the pure random and discriminating random subtractive modes, in which each unit of defense potential would see and could intercept any RV in the enemy attack. As long as the number of attacking RVs equaled or exceeded the total capability of the defenses to subtract out RVs, every unit of defense potential would be used. In contrast, discriminating semipreferential defenses would not perform quite as well when the

level of defense potential approached or exceeded the number of enemy killer RVs.

This operational difference among the various defense modes implies that, for initial deployment of defenses, the defender should seek to attain the capability to operate them in a semipreferential mode. The payoff would be high, because preferentially defending certain targets would guarantee that a certain percentage would survive.

As the level of defense potential increased, however, this payoff would decrease until, finally, at modest to high levels of defense, the defender would incur a penalty for operating the defenses in a semipreferential mode. Fewer targets would survive than if the defense were operated in a pure random or discriminating random subtractive mode. Thus, at moderate to high levels of defense, the defender should switch modes and operate his defenses in either of the latter two modes, preferably, the discriminating subtractive (see Table A.1, above).

Discriminating Complete Preferential Mode

Of all the defense modes discussed in this appendix, complete preferential defense requires by far the most information and battle management skill. Complete preferential defense would mean that the defender had the capability to preferentially defend certain targets within the overall target set, such as specific ICBM silos or command and control nodes of the defense itself, *after* determining the character of the enemy attack.

To operate a complete preferential defense optimally, a defender would have to know the total size of the attack and the allocation of attacking RVs to particular targets. As with two of the previously discussed modes, the defender would have to be able to discriminate killers from nonkillers and preferentially attack the killers.

Thus, the defender would not only have to obtain nearly perfect knowledge about the exact character of the attack, he would also have to be able to act on this information and operate his defenses to best effect. In short, complete preferential defense would require (1) perfect knowledge about the character of the attack and (2) defenses that could fully adapt to and exploit any anomalies.

The formula to calculate the expected fraction of targets surviving (P_s) if the defense were operating in a discriminating complete preferential mode is simply:[5]

[5]Like the formula for discriminating semipreferential defenses, this formula assumes perfect killer RVs and perfect interceptors.

$$P_s = \frac{D}{A_k}$$

If the defender were capable of operating the defense in a complete preferential mode, his ICBMs would have a good chance of surviving an attack (see Table A.1, above). For example, in both the discriminating subtractive and complete preferential modes the United States could protect all of its ICBMs if the defense potential equaled the number of Soviet killers (5000). The complete preferential mode, however, generates more surviving RVs early on in the deployment of defense potential. Given current forces, the United States would have to intercept only 2500 Soviet RVs to protect at least half of its ICBM forces, if the defenses were operated in a complete preferential mode. As we saw before, this requirement rose to nearly 4200 in the case where U.S. defenses were operated in discriminating subtractive mode and even higher for the other two modes.

As one can see in Table A.1, above, the greatest difference in terms of P_s between complete preferential defense and the other operating modes, particularly the discriminating subtractive mode, occurs in the range of small-to-modest amounts of U.S. defense potential. However, if the U.S. defenses could discriminate killers from nonkillers and the defenses could intercept 5000 RVs or more, 100 percent of the targets would survive, whether the defenses operated in the complete preferential mode or in the discriminating subtractive mode.

Soviet ICBM survivability in the presence of strategic defenses as depicted in Table A.1 differs substantially from the U.S. case. Since the ratio of U.S. attackers to Soviet aim points is only slightly greater than one, the introduction of Soviet defense would pay immediate dividends, regardless of the mode in which the additional defense operated.

In fact, as shown in Table A.1, above, our analysis suggests that the Soviets would not need to deploy defenses that required a great deal of battle management to ensure that a large percentage of their ICBM force survived. In other words, the Soviets could protect much of their ICBM force at low to moderate levels of defense with the defense doing nothing more than randomly subtracting out U.S. RVs or at most U.S. killer RVs. To protect its ICBM force, the United States would have to deploy moderate to high levels of defense and/or be able to operate these defenses in a sophisticated manner, such as the complete preferential mode.

The above formula for the complete preferential mode, like the other three formulas in the appendix, would provide a defense enforceable solution. By that we mean that if the defenses operated in a complete preferential mode, the defender could guarantee that at least D/A_k

The above formula for the complete preferential mode, like the other three formulas in the appendix, would provide a defense enforceable solution. By that we mean that if the defenses operated in a complete preferential mode, the defender could guarantee that at least D/A_k targets would survive an enemy attack. However, owing to the nature of complete preferential defenses, the defender could take advantage of any anomalies in the attack and protect those targets that were lightly attacked.

The capability to react to the attacker's allocation of RVs to individual targets would enable the defender to protect more than D/A_k targets, if the attacker did not distribute his killer RVs uniformly over the target base. A corollary of this statement is that if the enemy's targets were of uniform value and his defenses operated in a complete preferential mode, an attacker's best strategy would be to attack all targets uniformly; by attacking in this manner the fraction of surviving enemy targets would be reduced to D/A_k. Any other attack strategies would result in a higher percentage of targets surviving.

Local Defenses

Local, or terminal, defenses are traditionally thought of as consisting of ground-based radars and interceptors with limited range. These defenses would defend specific point targets or regions by intercepting attacking RVs as they reentered the earth's atmosphere. Given these limitations, the most effective mode local defenses could operate in is discriminating semipreferential (or, if incapable of distinguishing killers from nonkillers, nondiscriminating semipreferential).

To operate the defense optimally in this mode, the defender would have to allocate his interceptors in advance to protect certain targets and then would have to be able to preferentially attack only the RVs headed for these targets. If the offense dominated and less than half of the total targets were expected to survive, $(2A/T) - 1$ would represent the largest number of interceptors that the defender should place at a single target at any time. The expected fraction of surviving targets (P_s) would equal to $D/(2A - T)$. If the defense dominated, $2D/T$ would be the highest level to which the defender would have to protect any silo. In this case, $P_s = 1 - A/(2D + T)$.

If the offense dominated and A was larger than T, as is the case today with Soviet attackers and U.S. ICBM targets, the P_s of U.S. targets would be very low even for modest levels of U.S. local defense. For example, if the U.S. were to defend its 1000 ICBM sites with 2500 perfect interceptors, a defense potential equal to half of all Soviet killer RVs, less than 30 percent of U.S. ICBMs would likely survive:

$$P_s = \frac{D}{2A - T}$$

$$= \frac{2500}{(2 \cdot 5000) - 1000}$$

$$= \frac{2500}{9000}$$

$$= .28$$

This formula is precisely correct when the probability of kill of an enemy warhead is 1.0 and the probability of intercept of one's own interceptor is 1.0. In Figs. 8 and 9, above, in which we included U.S. deployment of local interceptors operating in a semipreferential mode, we assumed perfect U.S. interceptors. However, Soviet warheads had a P_k less than one. The P_s for these cases would accordingly be slightly higher than the expected value for P_s produced by using these formulas.

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